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Annotated Bibliography on Technological Forecasting

Martha M. Gray * David A. Nagy **

* Computer Information Section
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National Bureau of Standards
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** Division of Systems Coordination and Planning
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Baltimore, Maryland 21235

March 1974

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ANNOTATED BIBLIOGRAPHY ON TECHNOLOGICAL FORECASTING

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U. S. DEPARTMENT OF COMMERCE, Frederick B. Dent, Secretary

NATIONAL BUREAU OF STANDARDS, Richard W. Roberts, Director

ANNOTATED BIBLIOGRAPHY ON TECHNOLOGICAL FORECASTING

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FOREWORD

This annotated bibliography of over 100 references on technological forecasting is the first report prepared by the National Bureau of Standards, Department of Commerce, for the Social Security Administration, Department of Health, Education and Welfare, under an Interagency Technical Services Agreement for ADP Bibliographic Search and Evaluation. These references were selected in a survey of the technical literature, mainly from the years 1968-1973, for information on technological forecasting as applied to information processing and automatic data processing.

Some of the references should be considered primary sources for forecasting while others provide further background information. Some information is included which is of a general nature but which would be helpful to a novice in the field. Other publications are highly technical and would only be of use to someone preparing a forecast or studying forecasting methodologies.

The format of the information provided on each reference included in the annotated bibliography is as follows:

Citation: author, title, publication, volume, issue, date of publication, inclusive pages, number of references, conference note, contract number, author's organization, total pages, publisher and report numbers, where applicable.

Abstract: a brief review of the reference indicating the important aspects of the document and its appropriateness for the Social Security Administration's use.

Keywords: words or terms which identify the important concepts and which describe the contents of the document.

Code: identifier of reviewer, the reviewer's organization and the date of the review.

The references are listed in alphabetical order by author's name. Where there is neither a personal author nor a corporate author, the references are listed by title. In addition, there is an index of titles in alphabetical order at the end of the report.

This bibliography references a collection of documents which are intended to be of use to SSA's planning staff. Since the authors recognize that it may not be complete, readers are encouraged to

provide information on references that should have been included. It should be noted that this bibliography does not contain references to specific areas of the computer field, i.e., material relating to data entry, storage, or output devices. It is planned to include references specific to given subject areas of information processing of interest to SSA in a later bibliography.

ACKNOWLEDGEMENTS

The authors acknowledge the extensive assistance provided by members of the Information Technology Division, Institute for Computer Sciences and Technology, National Bureau of Standards and of the Division of Systems Coordination and Planning, Social Security Administration, in preparing this report. Invaluable assistance was provided in locating sources, collecting documents and preparing manuscripts, for which special recognition is given to Mrs. Jackie B. Jones and Mrs. Sandy K. Sweeney of the National Bureau of Standards.

INTRODUCTION

Forecasting and planning are important daily activities at the Social Security Administration. They are an integral part of preparing--

- legislative proposals,
- program implementation,
- operational plans,
- budget and financial forecasts.

The shaping and selection of the strategies and tactics for these and other needs must revolve around the resources available - physical, personnel, financial and technical.

Technical resources are the most volatile and diverse of these resources, both in the capabilities presently available and in the future technology that will be needed for oncoming programs. Precise and reliable knowledge of future technology is of course impossible; for the most part, its characteristics must be inferred from a wide spectrum of information sources. Yet, effective long-range planning requires reasonably reliable estimates of information processing technology that is apt to exist at a further date.

To provide such technological prognoses is not a simple undertaking. The constantly expanding roster of suppliers and vendors, the ever lengthening inventory of problems solved, the streams of announcements of new technology from laboratories and research organizations, the flow of patents issued, and the flood of scientific and technical articles, papers and reports must be all taken into account in attempting to assess the probable state of information processing capabilities at some given time in the future. All of this information must be analyzed and distilled for the most important aspects and the anticipated results matched to SSA needs.

The first aspect that becomes readily apparent in a review of the available information is the wide range of viewpoints on forecasting and the diverseness of terminology. To fulfill the needs of SSA certain references were found to be much more useful than others. Information sources containing such terms as "future of computing", "trends in technology", "technological advance", "technological change", "technological planning" and "technological forecasting" seem to be more representative of the needs of SSA.

There is a great amount of literature on technology assessment but much of it has been excluded from this bibliography. Technology assessment seems to imply a meaning quite different from technology forecasting. In a report of the National Academy of Engineering's Committee on Public Engineering Policy to the Committee on Science and Astronautics of the U.S. House of Representatives entitled "A Study of Technology Assessment," the phrase "technology assessment" was introduced "to characterize the sociotechnical research that discloses the benefits and risks to society emanating from alternative courses in the development of scientific and technological opportunities."

In "A Study of Technology Assessment Today," prepared for the National Science Foundation by Peat, Marwick, Mitchell and Co., technological assessment is defined as "the process of identifying the actual or potential secondary effects of a technological development (or of a set of interrelated technological developments) on social, political, economic, and/or environmental values or institutions." Thus, the main thrust of technology assessment is not on technological development but on impacts of these developments. Since social impact assessment is not a primary concern of SSA, very little of this type of information has been included here.

However, this bibliography does include material on the methods and techniques of forecasting in general. It is important to know something about the technique used in a forecast if one is to judge the validity of the forecast. For example, one of the most famous errors in judgment that was passed on to the computing community was a prediction when the Univac I was announced that the total market potential for computers was six machines.

The literature on the methodologies of forecasting provides a basic background to better understand the forecasts themselves. Several methods are of interest and are included:

intuitive methods--including individual forecasts by "experts", polls, panels and the Delphi technique with its modifications;

development of scenarios;

trend extrapolation--including simple trend extension, curve fitting with judgment and envelope curves;

statistical techniques--including regression and correlation analysis and precursor events;

analogies--including historical and growth analogs; and

modeling--including gaming-simulation, interindustry input/output analysis, and network methods.

Lastly, the paragraphs below emphasize the value of forecasting and its applications to industry and government:

1. "During the past quarter century, a vast expenditure of human and economic resources has been invested in research and development. The greater portion of this effort has sought, with marked success, to apply existing knowledge to the solution of operational problems in industry and government. To a remarkable degree, tractable solutions have been generated leading to a more efficient, less costly, and faster ways of doing things once considered to be technically impossible. These huge investments in research and development have prompted management to forecast technology in hopes of being able to monitor and presage technological growth."
[Underlining added]

Bernstein, George B., "A Fifteen-Year Forecast of Information-Processing Technology," Naval Supply Systems Command, Washington, D.C., Research and Development Division, 20 January 1969, p. 1-2.

2. "It is important to foresee as clearly as may be possible, the nature and possible impact of a rapidly growing technology. ... Science and technology are increasingly recognized as influences in the transformation of society and governments must therefore strive to foresee the impacts which technological developments are likely to have on future society and to guide the application of new knowledge in the attainment of national goals."

Jantsch, Erich, "Technological Forecasting in Perspective," Organization for Economic Co-operation and Development, Paris, France, 1967, p. 11.

3. "We need acceptance of the fact that technological forecasting can provide a powerful tool for planning. ... What is needed now is more than grudging acceptance, more than rhetoric and emotion. What is needed is understanding of the techniques and methods, and a willingness to employ them. Further, we need working managers to develop and use technological forecasting in their normal planning activities."

Bernstein, George B. and Lawrence A. Feidelman, "Data Processing. Forecast 80," Management Information Corporation, Cherry Hill, New Jersey, 1971, p. 1.

It is hoped that this report and the data base it represents will help the Social Security Administration take advantage of the true value of technological forecasting by providing sufficient information to apply forecasting techniques to ongoing operational requirements.

Amara, Roy C. and Gerald R. Salancik, "Forecasting: From Conjectural Art Toward Science," Technological Forecasting and Social Change, Volume III, 1972, p. 415-426.

The objective of this paper is to examine somewhat critically, but constructively, an essential element in futures research; namely, forecasting. In particular, an attempt will be made to review the purposes that forecasts can serve, to suggest guidelines for how they may be made more useful instruments for research and decision-making, and to outline criteria by which they may be evaluated. To do this, the paper is organized as follows: Section II briefly relates forecasting to futures research. In Section III, forecasting is defined. In Section IV, six measures or indicators for evaluating a forecast are described. Section V presents three principal criteria for evaluation of forecasts and illustrates the application of such criteria with the use of several simple examples. A short summary is given in Section IV. (Author)

This article would be of interest as a general introduction to the field of forecasting and the ways of evaluating forecasts.

Keywords: Futures research/ Definition of forecasting/ Forecast evaluation/ Quality of forecasts/

MMG:NBS:12/12/73

Armer, Paul, "Computer Aspects of Technological Change, Automation, and Economic Progress," the Rand Corporation, Santa Monica, California, 1966, 27 p. (reprinted from National Commission on Technology, Automation, and Economic Progress, "Technology and the American Economy. Appendix Volume I. The Outlook for Technological Change and Employment," U.S. Government Printing Office, Washington, D.C., February 1966, p. I-205 - I-232.)

This report, dated 1966, surveys the important trends in the computer field and their implications for several specific industries, and discusses the social implications of the increasing penetration of computers into our daily lives. Trends discussed include speed, cost, computing time, ease of use and a general wider spread usage. Two applications are primarily discussed: Banking and financial usage, and government use. Education with respect to computer applications within education and education in the computer sciences are highly stressed. Although this report is out-of-date, it can provide insight for the forecaster today by presenting previous reports for presentday comparison. This report discusses, in detail, much of what is still pertinent: Education and applications.

Keywords: Applications/ Education/

DAN:SSA:9/21/73

Arnfield, R. V. (Ed.), "Technological Forecasting," Edinburgh University Press, Edinburgh, Scotland, 1969, 418 p.

This book is a collection of papers presented at the "European Conference on Technological Forecasting," sponsored by the University of Strathclyde and held in Glasgow in June of 1968. The papers are divided in three sections. The first section presents a general discussion of technological forecasting, including the history of forecasting, different views on forecasting and areas where forecasting may be used. Section two contains papers on the techniques and methodologies used in forecasting, including Delphi, morphological methods, social benefit analysis and trend projection. The third section includes projections of the future for the following areas, energy, automation and process control, manufacturing, construction, urban development, and transportation. This book is a good general text but does not include many specifics. It should not be considered a primary source of projections of computer related areas.

Keywords: General discussion/

MMG:NBS:1/17/74

Auerbach, Isaac L., "Technological Forecast," in Fred Gruenberger (Ed.), Expanding Use of Computers in the 70's. Markets, Needs, Technology, (Prentice-Hall, Inc., Englewood Cliffs, New Jersey), 1971, p. 11-23. (Prentice-Hall Series in Automatic Computation)

This article is very similar to the two-part series by Auerbach in Data Systems. Auerbach surveys some developments which may occur in the 1970s for systems hardware and software. Some developments mentioned are new theories for the design of information systems, less use of low cost fast magnetic core memory, and greater use of large-scale integrated solid-state memories, availability of magnetic bubble memory, greater storage capacity for magnetic tapes, greater use of read-only memories, changes in input and output techniques and devices, major strides made in data communications and software that is properly defined, designed and tested. Either this article or the ones in Data Systems deserve looking into. The projections are based on good foundations and, if they follow other predictions made by Auerbach, have a better than average chance of coming true.

Keywords: Technological projections/ Hardware/ Software/ Information systems/ Technological forecasts/

MMG:NBS:1/25/74

Auerbach, Isaac L., "Technological Forecast 1971," in IFIP Congress 71, (North Holland Publishing Company, Amsterdam, Netherlands), 1971, IFIP Invited and Submitted Papers, p. I-236 - I-248.

This paper is a forecast of developments occurring in ADP, not necessarily in 1971. Forecast are events and trends in hardware (arithmetic and control units, memories, peripheral devices), software, and systems. A decrease in processor time and cost, an increased dependence on LSI along with a continued predominance of magnetic core memories, and a slow evolution in peripherals due mainly to mechanical limits are foreseen, while the software problems will continue because software development has not evolved to a "classical engineering tradition" as has hardware technology. Auerbach sees a trend toward better, more user-oriented software. Under systems, discussed are topics in distributed intelligence, data communications, and systems design and management. This article is a very comprehensive paper on forecasting, providing much insight into an area often overlooked - systems.

Keywords: Central computers/ Memory/ Storage/ Peripherals/ Software/ Systems/ LSI/ Magnetic core/ Magnetic tape/ Magnetic disks/ Cards/ Input/ Output/ Distributed intelligence/ Communications/ Management/ Telecommunications/ Data entry/ Systems design/

DAN:SSA:9/14/73

Auerbach, Isaac L., "Technology and the Future," Data Systems, December 1970, p. 30-32.

In this first part of a two part series on future developments in information processing the author discusses possible hardware developments. Memory techniques are mentioned first, including the role of the most common memory used now, core, and its future, and developments of magnetic thin-film and plated wire memories, LSI solid-state memories, bubble memories and laser optical memories. Several predictions with specific dates are given including one that "magnetic bubble memories should be available during the second half of the decade."

Moving on to other hardware developments the author states that "probably the most rapid changes of all will be found among the devices for input, output and data communication." After comments on key-to-tape, magnetic cassette, optical character recognition and speech-to-digital conversion equipment he makes the prediction that "the next decade may well go down in history as the era of the output terminal." He closes the article with some general comments on data communications systems, time sharing and networking. The article is a good concise overview of some of the highly possible hardware developments in the near future.

Keywords: Technological forecasts/ Hardware developments/ Memory devices/ Input devices/ Output devices/ Data communications/

MMG:NBS:1/24/74

Auerbach, Isaac L., "Technology and the Future. Part 2," Data Systems, January 1971, p. 12-13.

This paper is a discussion of the future of software and systems organization. Concepts discussed and the methodology used for this discussion provide the reader with a good insight into the problem of software and the complexity of system organization. Auerbach points out as an example of poor planning and the non-technological art of software the fact that it took five years for the 360-OS to evolve after the hardware. Software lacks a technology or scientific method of development while the systems organization discipline lacks a true systems theory. Listed in the article are six developments likely to influence software and systems within the near future. Also highlighted by Auerbach is the fact that most forecasts are overstated, trying to predict what will be the crucial technological advance which is expected by the end of the decade.

Keywords: Software/ Systems/ Systems theory/

DAN:SSA:9/14/73

Avebury, Eric Lubbock, Lord, Ron Coverson, John Humphries and Brian Meek, "Computers and the Year 2000," National Computing Centre, Ltd., Manchester, England, 1972, 319 p.

The title of this publication may be a bit confusing but it is not a science fiction type document at all. Rather this is a collection of papers on forecasting the growth of the computer industry until approximately the turn of the century. Some of the publication is narrowed to the computer industry in Great Britain in the past, present and future. However, most of the papers are applicable to any geographical region and are discussing the role of computers in general.

Forecasts of computing are given for many application areas, government, medicine, education, utilities, banking and manufacturing to name a few. The papers are not concerned with specific technical developments in hardware or software but are concerned with the role of computers in many industries or areas in the next decades. Some papers discuss the social impacts of computers on the quality of life, the environment, everyday living, cultural development, crime and privacy. The book ends with two papers on "politics in a computerized world" and "tasks ahead," work which must be done to prepare for the future.

Keywords: Computer applications/ Industrial impact/ Quality of life/ Medicine/ Education/ Banking/ Manufacturing/ Environment/ Crime/ Privacy/

MMG:NBS:1/30/74

Ayres, Robert U., "On the Sustenance of Technological Innovation," Technological Forecasting and Social Change, Volume III, 1972, p. 273-278.

This short article is included as a reference in this data base mainly because it is written by Robert Ayres. In this article he discusses the virtues of technological innovation, a factor to be considered in forecasting technological developments. The author defines innovation as "mating an idea with a social need, designing a new product or service which can be supplied at a price low enough to satisfy a latent economic demand, but high enough to generate profits for the producer." He discusses examples of good technological innovation and examples of programs which he feels are wastes of money and are not advancing innovation. This article is not of great value to SSA but since many other publications of Ayers are very important, this one is included to further indicate some of the other thoughts of the author.

Keywords: Technological innovation/ Definition/ Role in society/

MMG:NBS:3/4/74

Ayres, Robert U., "Technological Forecasting and Long-Range Planning," McGraw-Hill Book Company, New York, 1969, 237 p.

After giving an historical perspective on technological forecasting back to the days of the oracles, the author discusses types of forecasts, dimensions of technological change, morphological analysis, extrapolation of trends, heuristic forecasts, intuitive methods of forecasting, policy and strategic planning, planning at the operational level and planning future research. The monograph provides an excellent basis on techniques which are available for forecasting and practical examples of utilization of these techniques. It is not application oriented, that is it does not give forecasts for any industry or occurrence, but it does give a planner the tools necessary for his job. It should be considered a textbook on forecasting and long-range planning.

Keywords: Morphological analysis/ Trend curves/ Heuristic forecasts/ Policy planning/

MMG:NBS:12/3/73

Bar-Zakay, Samuel N., "Technology Transfer Model," Rand Corporation, Santa Monica, California, Report No. P-4509, November 1970, 31 p. (AD-731 271).

The paper presents a model of technology transfer with these objectives in mind: To suggest a list of activities to be undertaken in a specified sequence by individuals and organizations intending to engage in a technology transfer project; and to point out topics in which knowledge is limited and more research is required. (Author)

Since technology transfer is only a minor part of SSA's interest this article is only of secondary reference.

Keywords: Modeling/ Transfer of technology/

MMG:NBS:12/4/73

Bauer, Raymond A., "Second-Order Consequences. A Methodological Essay on the Impact of Technology," The M.I.T. Press, Cambridge, Massachusetts, 1969, 240 p.

This book is the third and final volume in the series "Technology, Space and Society," prepared by the American Academy of Arts and sponsored by the National Aeronautics and Space Administration. The purpose of this volume is to look at the problems of managing the consequences of technology. The basic premise is that every technological advancement breeds second-order consequences, i.e., that every technological advancement produces an effect on society and also "seeds of new technology that can 'drop out' and bear fruit in other areas of research." Thus not only do the changes in technology need to be studied but also the second-order consequences.

The author develops a methodology for analyzing these second-order consequences, presents applications of the methodology and gives an overview of the impact of the space program on certain groups. Since the computer field is one which has already shown to have technological impact on other areas and societal effects, this book is well worth studying.

Keywords: Technological impact/ Technology transfer/ Social consequences/ Second-order effects/ Space program/

MMG:NBS:1/14/74

Bernstein, George B. and Lawrence A. Feidelman, "Data Processing. Forecast 80," Management Information Corporation, Cherry Hill, New Jersey, 1971, 193 p.

This report is not a text on technological forecasting but a report on actual forecasts of the computer industry through 1981. A brief history of the computer industry is presented including a table chronologically listing historical events in data processing. Goals and desired trends for the next decade and beyond are discussed. After sections on forecasting methods and planning for data processing developments, technological forecasts are presented for hardware (speed, size, weight), memory, peripherals, software, data entry, data communications, microforms and systems. An additional section is given on data processing applications forecasts in the following areas, business, home, education, printing and publishing, environment, medical, automated design, law enforcement, finance, transportation, and postal service. Charts are included with the forecasts which show the probability of certain occurrences by certain years. Three years are given showing a twenty percent, fifty percent and ninety percent chance of the occurrence. Thus there are not just very general statements of the future but are also indications of when these events really may come to be.

This report is one of a very few documents which has a compilation of forecasts covering the whole computer industry including a time table of hard facts. Some of the predictions would be well worth checking now and in the next few years.

Keywords: Technological forecasts/ Hardware/ Software/ Peripherals/ Data communications/ Applications/ Forecasting methods/

MMG:NBS:12/3/73

Bernstein, George B., "A Fifteen-Year Forecast of Information-Processing Technology," Naval Supply Systems Command, Washington, D.C., Research and Development Division, January 20, 1969, 181 p., 217 refs. (AD-681 752).

This paper describes the evolution of the SEER (System for Event Evaluation) by the U S Navy Supply Systems Command. SEER is a modified DELPHI approach to technological forecasting, applied to a 15-year, user oriented, investigation of future potential in 14 information processing categories.

The SEER technique includes two levels of action -- Round I, the development of an anticipated event data base by equipment industry experts; and Round II, a intuitive review of the data base events by a panel of experts. Seven problems involved in the use of DELPHI were identified. Satisfactory solutions were developed for six of the seven problems and a method of handling the seventh one was postulated but not tested.

The paper includes an inventory of 485 predicted events in the 14 categories which have been evaluated by the expert panels in terms of Goals (Short, Mid-term, Long Range, Not Applicable); Feasibility (1 to 9 ranking); Desirability (1 to 9 ranking); and Timing (three points in time given corresponding to occurrence probabilities of $x = 0.20, 0.50, \text{ and } 0.90$). These time evaluations were made in 1968. A cursory review of several categories shows that the events are occurring for the most part at the times predicted or earlier.

The event forecasts were further structured into Event Relationship Models to illustrate the impact of necessary and supporting events as aid to program planning. The paper concluded that there were few existing gaps in hardware technology (as of 1969) save in the areas of input and communications. The author further observed that there was a gap in the application of technology to user needs -- "... a gap in learning how to efficiently use and effectively manage the utilization of hardware (exists) rather than how to make it."

To improve communication to potential users, the study suggested that four areas be emphasized -- satisfaction of user requirements; standardization of procedures; equipment, software, and data elements; make equipment an extension of man; and adopt new ways of organizing the machine and systems of machines.

This paper is a landmark study in the history of technology forecasting in the area of information processing. It contains much of use to SSA programs. The fact of its 5-year existence makes it possible to evaluate its effectiveness, in 1973, by reviewing the extent to which forecast events have or have not occurred.

Keywords: Technological forecasting/ Future of computing/ DELPHI method/ SEER (System for Event Evaluation)/ Method/ Technological planning/ Equipment utilization/ Man-Machine interfaces/ User requirements/ Standardization/ Data elements and codes/

Blackman, A. Wade, "Forecasting Through Dynamic Modeling," Technological Forecasting and Social Change, Volume III, 1972, p. 291-307, 9 refs.

The techniques of industrial (system) dynamics were applied to simulate a representative industrial research laboratory and to forecast the effect on future laboratory operations of matching an exploratory forecast of the laboratory's output to an exogenous goal schedule set by normative forecasts of future requirements.

The laboratory operating policies which were found to produce stable growth patterns in response to normative growth goals were found to be different from those which would have been intuitively expected to produce stable growth. This finding is in agreement with the work of other investigators which has pointed out the unreliability of intuition when applied to multiloop, high-order, nonlinear feedback patterns characteristic of most management and social systems.

The simulation outputs forecast (1) the future balance between government and internal support required to achieve the normative goals, (2) future personnel and facility requirements, (3) capital expenditures, and (4) the decision criteria required to achieve the goals and to assure orderly growth of the laboratory. The simulation also produces data which determine the long-term costs of achieving the normative goals and thereby allows benefit-cost comparisons of internally produced R D with R D obtained through acquisition and merger or licensing opportunities. (Author)

This article describes another method of forecasting. The method described is not a commonly used method but would be of interest to someone studying various forecasting methodologies.

Keywords: Industrial dynamics/ Simulation/ Normative forecasts/ Growth patterns/ Laboratory operations/ Research and development/

MMG:NBS:12/5/73

Blackman, A. Wade, Jr., "A Mathematical Model for Trend Forecasts," Technological Forecasting and Social Change, Volume III, 1972, p. 441-452, 14 refs.

A mathematical model is developed which provides a basis for the extrapolation of technological performance figures-of-merit, and the resulting equation which describes the rate of technological progress has the form of a logistic curve. The model predictions are compared with historical development trends which have occurred for the development of transportation capability, for the otto cycle engine, and for the diesel engine. Methods are developed for estimating uncertainty levels associated with technological figure-of-merit projections, and the relationships between technological progress and market substitution are discussed. (Author)

This article describes another model for forecasting. After other models were compared this model was developed to include certain uncertainty characteristics that are in any forecast. It would be of interest to anyone studying forecasting methodologies.

Keywords: Figure-of-merit projections/ Technological progress/

MMG:NBS:12/6/73

Blackman, A. Wade, Jr., "The Use of Bayesian Techniques in Delphi Forecasts," Technological Forecasting and Social Change, Volume II, 1971, p. 261-268, 12 refs.

Procedures are developed which allow an estimation to be made of the uncertainty associated with Delphi forecasts and which allow the judgment and intuition of the decisionmaker using the forecast (and/or statistical data on the accuracy of past Delphi experiments) to be incorporated into and impact upon the forecast results. The methodology utilized relates the confidence probability of the forecast of and event to the dispersion of individual estimates of the elapsed time for the event to occur. The confidence probabilities of individual estimates are then modified by the outcome of the group estimate and the decisionmaker's subjective judgment through the use of Bayesian techniques. The final forecast is obtained as the sum of the individual estimates weighted by their modified confidence probabilities. (Author)

The technique described considers the reliability of a Delphi forecast. It would be of interest to anyone studying forecasting techniques but more specifically to someone utilizing Delphi techniques.

Keywords: Delphi forecast uncertainty/ Confidence probability/ Forecast reliability/

MMG:NBS:12/7/73

Blackwell, F. W., "The Probable State of Computer Technology by 1980," Journal of Educational Data Processing, 9:1-2 (1971), p. 12-17, 8 refs.

This paper deals with a perception of computing technology in 1980. It dwells into many areas, dealing with each in detail. Topics covered include: Large computers, minicomputers, terminals, powerful languages, applications, time-sharing, and computer networks. This paper is education-oriented, although much is forecast applicable to most users, particularly in hardware, applications and the powerful languages. This report is precise and concise, presenting each topic thoroughly and without use of statistics, dealing primarily with each topic's probable state in 1980.

Keywords: Central computers/ Minicomputers/ Terminals/ Languages/ Applications/ Time-sharing/ Networks/ Education/ Hardware/ Software/

DAN:SSA:8/10/73

Bowers, Don M., "Predicting Future Computer Developments," Modern Data, 6:5 (May 1973), p. 62-64, 66-68, 9 refs.

This article describes a technique of technological forecasting. When many articles are simply saying what may happen, Bowers tells why. In the article, Bowers begins by illustrating his Limit by example of the growth of telephones. He describes it mathematically, keeping the telephones as a descriptive example. To illustrate his Limit, Bowers uses basically two parts; the people and the environment. Each, in turn, is analyzed as problems in technological growth. In relation to ADP, Bowers' Limit applies when limits are approached in areas like magnetic storage densities. (There is a limit to the amount of data storable in one square inch or millimeter). Bowers' Limit is described logically and in detail, showing how forecasts in certain areas are developed by predicting further technological development when limits are approached.

Keywords: Forecasting/ Density/ Magnetic storage/

DAN:SSA:8/23/73

Bradburn, J. R., "Where is the Computer Industry Heading?," Computers and Automation, 19:11 (January 1970), p. 10-13.

This article describes the problems facing the ADP field during the fourth generation and forecasts the possible solutions. This paper deals with many intangibles of ADP, e.g., personnel, man/machine interfaces, and the computer mystique, and attempts to define the probable paths taken by each during the fourth generation. The article addresses itself to the problems of inadequate education of valuable ADP personnel, the "super-brain" myth associated with computers, and the phobia associated with data bases and privacy. Forecasts are made in education, software and its usage, time-sharing, computer speed, and holographic advances in ADP. The direct confrontation of the man/machine interfacing, education, and resistance-to-change problems lends this article well to the user and provider of ADP services.

Keywords: Education/ Software/ Time-sharing/ Holography/ Memories/ Storage/ Data entry/ Cards/ Magnetic tapes/ Fourth generation/ Communications/

DAN:SSA:8/9/73

Bright, James R., "Technology Forecasting - New Tools for an Old Responsibility," Research Management, July 1972, p. 50-65.

This article gives a comprehensive overview of technological forecasting tools and suggests ways to apply them. The tools are trend extrapolations, monitoring, normative forecasting, simulation, scenarios, and cross-impact analysis. Each is very detailed yet easy to comprehend for both the technical reader and the passive reader. Of the subcategories listed, analogies, envelope curves, substitution theory, technological progress function, step functions, morphological analysis, social-technological planes, relevance trees, and mission-flow analysis are among these categorized under trend extrapolation and normative forecasting. All topics are well documented and clearly defined, providing the reader with a better insight into the field of technological forecasting. This article is the most comprehensive paper relating to technological forecasting this reviewer has seen to date.

Keywords: Trend extrapolation/ Monitoring/ Normative forecasting/ Simulation/ Scenarios/ Cross-impact analysis/

DAN:SSA:11/1/73

Bright, James R. and Milton F. Schoeman (Eds.), "A Guide to Practical Technological Forecasting," Prentice-Hall Inc., Englewood Cliffs, New Jersey, 1973, 651 p.

This book is a collection of articles used by the Industrial Management Center, Inc., for courses from 1968 through 1971. "The goal of this book is to advance practical technological forecasting by presenting new materials emerging from industry, government and academia in the last five years." The following information is presented, new forecasting theories and concepts (descriptions of Delphi studies have been purposely left out), actual forecasts for many areas including computer memory market, computer industry, business management, and jet engines, "approaches to improving technological forecasting through insight on areas affecting technology developments--the environment, political forces, and social change," and "descriptions of how successful technological forecasting efforts have been organized."

The individual contributing authors in this volume are well known and respected for their knowledge in the field. Included are Martino, Blackman, Cetron and Jantsch, to name a few. The book supplements a previous volume, "Technological Forecasting for Industry and Government" and brings the field up to date to the fall of 1971. It is definitely well worth reading for anyone interested in technological forecasting or applications of technological forecasting.

Keywords: Forecasting improvement/ Techniques of forecasting/ Methodology/ Technological forecasts/ Computer memory market/ Computer industry/ Jet engines/ Business management/ Forecasting organization/

MMG:NBS:1/11/74

Bright, James R. (Ed.), "Technological Forecasting for Industry and Government. Methods and Applications," Prentice Hall, Inc., Englewood Cliffs, New Jersey, 1968, 484 p.

This monograph is a collection of papers from twenty-eight contributors. Most of the papers are revised editions of those presented at "The First Annual Technology and Management Conference: Technological Forecasting for Industry." Divided into five major sections, the areas covered include: lessons on technological forecasting from history, techniques of forecasting, the integration of technological forecasting and environmental forecasting, applications of forecasting and the organization of the technological forecasting effort. The authors contributing to this monograph are well respected men in the field including Ayres, Cetron, Jantsh and Martino. Thus this includes many different viewpoints on forecasting all in one collection and is well worth investigating.

Keywords: Trend extrapolation/ Delphi/ Forecasting methods/ Environmental forecasting/ Applications/

MMG:NBS:12/3/73

Carter, Anne P., "Technological Forecasting and Input-Output Analysis," Technological Forecasting, Volume I, 1970, p. 331-345, 9 refs.

The author suggests in this article that the fields of technological forecasting and input-output analysis do overlap and that each supplies information and insight to the other. An explanation is given on the interrelationship of the two fields. In the second part of the paper the author shows some practical applications that involve the two fields and the ways in which information from the two fields help to solve the problems involved. The article does show that the economic information in input-output analysis should be some input to technological forecasting or technological projections.

Keywords: Input-output tables/ Economic research/ Information transfer/

MMG:NBS:12/12/73

Cetron, Marvin J., "Technological Forecasting. A Practical Approach," Technological Forecasting Institute (Gordon and Greach, Science Publishers), New York, 1969.

Much has been written about technological forecasting but very little about the practical uses of forecasting or examples of technological forecasting prepared and used for research and development planning. Thus the aim of this author was to prepare a text that would show the practical utilization of forecasting. The areas covered include; the framework and philosophical basis for technological forecasting, forecasting use in the Department of Defense and other government agencies, basic forecasting techniques and an introduction to normative forecasting, mechanics of technological change, examples of problems involved in forecasting including the Navy Technological Forecast, the Delphic methodology, resource allocation, quantitative methods, case studies of forecasts and organization involved in forecasting. This is not a text on the theories of forecasting nor a discussion of future developments in forecasting. Rather it is a handbook of tools for utilizing technological forecasting now in management planning.

Keywords: Delphi/ Resource allocation/ Quantitative methods/ Case studies/

MMG:NBS:12/3/73

Cetron, Marvin J. and Bodo Bartocha (Eds.), "The Methodology of Technology Assessment," Gordon and Breach Science Publishers, New York, 1972, 235 p. (LC 72-81110)

This book is another collection of papers from many authors. In the summer of 1971 the editors decided that technology assessment warranted a "state-of-the-art" study. The results of this study are the papers in this book. Many viewpoints are presented on different methodologies, a systems approach, including societal indicators, role of law, measurement, use of cross-impact matrix approach, the trimatrix, an integration technique, macro-assessment, and social responsibilities. Also included is the table of contents for another book, "Technology Assessment in a Dynamic Environment". This book is basically the larger set from which "The Methodology of Technology Assessment" was taken. Judging from the table of contents the larger book looks much more complete and worthwhile reading than this one. Since Cetron is one of the better known authors in the field of forecasting and assessment, this document should be part of the data base but not a primary source.

Keywords: State-of-the-art/

MMG:NBS:2/19/74

Coates, Vary T., "Technology and Public Policy. The Process of Technology Assessment in the Federal Government. Summary Report," The George Washington University, Washington, D.C., Program of Policy Studies in Science and Technology, GQ-4, GI-30422, GI-30422 #1, NGL 09-010-030, July 1972, 47 p.

The purpose of the research reported in this and two other reports, "Technology and Public Policy. The Process of Technology Assessment in the Federal Government. Volume I Final Report" and ". . . Volume II--Appendices" was to carry out an empirical investigation of the assumption that the existing process for planning and evaluating technological projects and programs within federal executive agencies is fragmented, diffuse, and inadequate in scope and depth. The research was also to provide a descriptive and analytical overview of the process of technology assessment as practiced in federal executive agencies in 1970-1971. The conclusions drawn from the research and recommendations for the improvement of technology assessment in federal agencies are included.

Since this report is a summary of the full report in two volumes it presents the highlights of all the research and main conclusions. For this reason it provides enough basic information to fill many needs in itself.

Keywords: Technological planning/ Technological evaluation/ Executive agencies/

MMG:NBS:2/22/74

Coates, Vary T., "Technology and Public Policy. The Process of Technology Assessment in the Federal Government. Volume I--Final Report," The George Washington University, Washington, D.C., Program of Policy Studies in Science and Technology, GQ-4, GI-30422, GI-30422 #1, NGL 09-010-030, July 1972, 336 p., 78 refs.

The purpose of the research reported in this report was to carry out an empirical investigation of the assumption that the existing process for planning and evaluating technological projects and programs within federal executive agencies is fragmented, diffuse, and inadequate in scope and depth. The research was also to provide a descriptive and analytical overview of the process of technology assessment as practiced in federal executive agencies in 1970-1971.

This volume presents all of the results of the study (less the interview information presented in ". . . Volume II--Appendices". It is divided into the following areas, the control and direction of advanced technology, current status of technology assessment in federal executive agencies, federal assessment of some major technologies, examples of technology assessment and conclusions.

Keywords: Technological planning/ Technological evaluation/ Executive agencies/

MMG:NBS:2/22/74

Coates, Vary T., "Technology and Public Policy. The Process of Technology Assessment in the Federal Government. Volume II--Appendices," The George Washington University, Washington, D.C., Program of Policy Studies in Science and Technology, GQ-4, GI-30422, GI-30422 #1, NGL 09-010-030, July 1972, 260 p.

This volume includes the appendices to the "Volume I--Final Report" of the same title. Appendix A "summarizes information gathered through 115 interviews with federal officials and others knowledgeable about the process of planning and evaluation of technological projects and programs." In the course of these interviews the officials were asked to provide examples of such studies. Appendix B describes 97 examples with a brief description of each study, methods used, level of effort, final output, etc. The examples are divided in several categories, wide scope assessments, partial or narrow technology assessments, problem oriented assessments, environmental impact statements, future studies and methodological studies.

Also included in this volume is a list of interviews including names, addresses and dates of interview and a list of the basic questions asked in interviewing.

Since the conclusions from these interviews and studies are summarized and presented in the other volumes this volume would only be of value for very specific details. Thus this volume is included as a reference document or secondary source. It is needed to complete the coverage of the research reported.

Keywords: Interviews/ Case studies/ Planning studies/

MMG:NBS:2/26/74

Cowperthwaite, Gordon H., "Some Thoughts on Computer Usage in the '70s," Management Controls, XIX:4 (April 1972), p. 65-68.

This article is a summation of events in ADP which have occurred and a prognostication of events yet to occur. This article makes an analysis of the past to reach some forecasting of the decade in ADP. Studied are the general hardware improvements of the 60s, communications improvements, and software improvements, ranging from minis through applications packages. A discussion of problem areas and possible solutions, including extensions of existing technology, is exercised. Forecasts are made with respect to MIS, user-attitude, mini usage, data entry, communications, and hardware. The author also examines Canadian ADP developments and expectations. The article provides an overview of past, present, and future ADP, although brief.

Keywords: Hardware/ Software/ Communications/ Minicomputers/ Applications/ Management information systems/ Data entry/ Canada/

DAN:SSA:8/10/73

"Crystal Balling: More Thought about the '70s . . . and Beyond,"
Infosystems, 20:2 (February 1973), p. 48-49, 83, 86-87.

This article is a synopsis of the Fall Joint Computer Conference and includes forecasting opinions of people in many industries involving ADP. Forecasts are made in different applications which tend to point out specific technological improvements. Applications discussed include; graphics, information centers, standardization, communications, military ADP, health care and ADP, process control, and insurance and ADP. Industries canvassed included aerospace, the railroads, education, the television networks, the military, hospitals, health insurance, and manufacturing. This article provides forecasting in a more general area of ADP, the applications.

Keywords: Graphics/ Standards/ Communications/ Applications/ Data banks/

DAN:SSA:8/9/73

Dalkey, Norman C., "An Elementary Cross-Impact Model," Technological Forecasting and Social Change, Volume III, p. 341-351, 2 refs.

Cross-impact analysis is a method for revising estimated probabilities of future events in terms of estimated interactions among those events. This Report presents an elementary cross-impact model where the cross-impacts are formulated as relative probabilities. Conditions are derived for the consistency of the matrix of relative probabilities of n events. An extension also provides a necessary condition for the vector of absolute probabilities to be consistent with the relative probability matrix. An averaging technique is formulated for resolving inconsistencies in the matrix, and a nearest-point computation derived for resolving inconsistencies between the set of absolute probabilities and the matrix.

Although elementary, the present model clarifies some of the conceptual problems associated with cross-impact analysis, and supplies a relatively sound basis for revising probability estimates in the limited case where interactions can be approximated by relative probabilities. (Author)

Keywords: Relative probabilities/ Probability matrix/

MMG:NBS:12/10/73

David, Edward E., Jr., "Some Questions on the Role and Effectiveness of Technology Assessment," Research Management, March 1971, p. 21-23.

With increasing uneasiness over the uncontrolled spread of technology, technology assessment is becoming more stressed as each advance progresses but questions remain. This article presents some questions which require consideration. The question asked first is "who assesses the assessors", followed by "what should the generic results of assessments be" and "what is the difference between assessments as proposed today and the usual marketing study and decision-making process of the past?" Each is discussed briefly and the author also discusses the problem with large-scale experiments saying those carrying out the experiments are too inexperienced. The only purpose carried out in this short paper is to raise questions already being asked of technology assessment.

Keywords: Technology goals/ Technology responsibility/

DAN:SSA:11/1/73

Davis, Ernest J., Jr., "Fundamental Limitations in Tracing the Origins of Technology," Office of Research Analyses, Hollman Air Force Base, New Mexico, Report No. ORA-70-0022, June 1970, 76 p. (AD-717 701)

A simple model from statistical communication theory is used to evaluate the probability of success in tracing research results which comprise origins of technology. The model has also been used to evaluate the probability of success in tracing research and technology origins of systems. A by-product of the study is the use of the same model for evaluating the probability of success of forecasting applications of research results and of technology advances. Use of the model has permitted the conclusion that certain fundamental limitations to successful tracing and forecasting exist. These limitations are analogous to well-known physical limitations in successful electrical communication -- bandwidth and noise. Bandwidth and noise are closely related to the classification systems for the originating categories (bandwidth) and for the receiving categories (noise). (Author)

Keywords: Modeling/ System origins/ Statistical communication theory/ Research results/

MMG:NBS:12/11/73

Day, Lawrence H., "The Future of Computer and Communications Services," in the 1973 National Computer Conference. Volume 42, (AFIPS Press, Montvale, New Jersey), 1973, AFIPS Conference Proceedings, (LC 55-44701), p. 723-734, 19 refs.

This article discusses, by use of the Delphi forecasting methods, the future of CAI and communications systems. It predicts future developments with regard to the "wired city" concept in CAI areas like home instruction, communications substitution in business and computer and communications services into the home. Experts consulted ranged from technical experts ("experts through research") and housewives, ("experts through experience") and each group discussed communications substitution possibilities, such as remote shopping, remote banking, etc. Also discussed within the article is what is a forecast, how is it conceived, how is it presented and organized, along with forecasts about CAI, in areas like at-home instruction, acceptance and problems, and also about communications substitutions (substituting communications for various aspects of business, where applicable, to allow for decentralization and relieve unnecessary city travel and congestion) in business. The article provides an explanation for forecasting rather than simple list or explain developments, and it specializes in CAI and communications, which allows for a more detailed forecast.

Keywords: Communications/ Computer-assisted instruction/ Education/ Forecast/ Technological forecasting/ Wired-city/ Delphi/

DAN:SSA:8/23/73

Dodson, E. N., "A General Approach to Measurement of the State of the Art and Technological Advance," Technological Forecasting, Volume I, 1970, p. 391-408, 13 refs.

In this article the author defines the state of the art as "the state of best implemented technology as reflected by the physical and performance characteristics actually achieved during the time period in question." A general approach to quantitative assessment of the state of the art and advances in the state of the art is presented. Interest in the state of the art is established since part of technological forecasting requires an accurate description of past and present technology. The author's concept of a forecast is a new state of the art. Thus he is basically trying to describe where we are with a better approach than now used so that the forecast of where we will be is more accurate. It is a theoretical paper but does give many illustrative examples.

Keywords: Quantitative assessment/ State of the Art/

MMG:NBS:12/12/73

Dressler, Fritz R. S., "Subjective Methodology in Forecasting,"
Technological Forecasting and Social Change, Volume III, 1972, p. 427-439,
 26 refs.

The state of the art in subjective methodology is summarized. In addition, viewpoints and insights into the nature of forecasting and subjective methodologies are offered. All are based on the fundamental idea that subjective data and processes are built into the very nature of forecasting. An examination of the research in subjective methodologies is made and found to be pursuing a common strategy--a strategy that parallels the multi-indicator development in objective methodology. This is termed the "SIG-process" strategy. It is further examined and articulated and found consistent with past and present research, expanding applications of subjective methodology, and future innovations incorporating computer and computer-related technology.
 (Author)

Keywords: Subjective Iterative Group Processes (SIG-processes)/

MMG:NBS:12/12/73

Dror, Yehezkel, "Technological Forecasting and Policymaking Reform,"
Technological Forecasting, Volume I, 1969, p. 109-111.

This article relates technological forecasting to policymaking, stating that technological forecasting will become a tool of policymakers to ease the impact of the application of technology. "The present state of policymaking permits either incremental change or shock-instigated erratic jumps in policies; but there seems to be no capacity for innovations in policy which are simultaneously far reaching, comprehensive and rationally-based." The author concludes by predicting that technological forecasters will be frustrated in their attempts to provide adequate forecasts of technology to the policymakers unless the policymakers redesign their art to accomodate technological forecasts. This article presents an excellent case for a change in policymaking for technological forecasting contributions.

Keywords: Role in policymaking/ Technology application/

DAN:SSA:10/29/73

Fedorovskity, Ye. and V. Siforov, "Forecast on Future Uses of Computer Technology," (translation), Joint Publications Research Service, Arlington, Virginia, JPRS 56250, June 13, 1972, 9 p.

This paper is a short, 9-page, report on US forecasting in the computer technology field and subsequent Russian comments on the US forecasts. The major US source for the forecasting is the Institute for the Future. Some of the specific areas forecast into are the rapid expansion of information and the massive miniaturization effort now being mobilized to tap the bases of information. After the forecasts are presented, Russian comments on their probability and applicability are made, along with examples of present Russian technology. The comments from the Russian Siforov lead this article for the reader, to allow him to see the Russian technology as it developed.

Keywords: Russia/ Miniaturization/ Information systems/

DAN:SSA:9/14/73

Fischer, Manfred, "Toward a Mathematical Theory of Relevance Trees," Technological Forecasting, Volume I, 1970, p. 381-389, 5 refs.

"This paper includes an operational definition of relevance numbers as used in evaluation matrices and relevance trees. This definition enables a better understanding of the concept, a derivation of the formalism, and an analysis of the error propagation in relevance trees. For technical systems a special measure of utility bases on distance in parameter space is introduced, which can be used to obtain relevance numbers from a computerized model of that process."

Relevance trees are used in research and development planning for two purposes, one to aid in creative thinking and second to aid in "deciding what subset of items provides the greatest progress toward the prescribed goal under a given financial constraint." This article is a theoretical one and should be used if information on the theory of relevance trees is necessary. No applications of relevance trees are given.

Keywords: Evaluation matrices/ Relevance numbers/

MMG:NBS:12/12/73

Fisher, J. C. and R. H. Pry, "A Simple Substitution Model of Technological Change," Technological Forecasting and Social Change, Volume III, 1971, p. 75-88, 5 refs.

In this paper a model for forecasting technological change is described and illustrated. The model was based on three assumptions: "1) Many technological advances can be considered as competitive substitutions of one method of satisfying a need for another. 2) If a substitution has progressed as far as a few percent, it will proceed to completion. 3) The fractional rate of fractional substitution of new for old is proportional to the remaining amount of the old left to be substituted." This model is described as simple to understand, tamperproof and is applicable to a wide variety of circumstances. The mathematical form of the model is described and shown to fit existing data. Some of the types of investigations where the model may be useful include: "forecasting technological opportunities, recognizing the onset of technologically based catastrophes, investigating the similarities and differences in innovative change in various economic sectors, investigating the rate of technical change in different countries and different cultures, and investigating the limiting features of technological change." Since the model is another technique that can be utilized in forecasting this article would be of interest to SSA.

Keywords: Technological opportunities/ Innovative change/
Technological forecasting/

MMG:NBS:3/4/74

Foster, Caxton C., "The Next Three Generations," Computer, 5:2 (March/April 1972), p. 39-42, 5 refs.

The author extrapolates from present technology to arrive at forecasts involving computers in the future as far ahead as 2000. Included in his predictions are memories, compilers, interpreters, addressing, operating systems, storage heirarchies, time-sharing, and mini-computers. Detailed are the changes occurring in programming, internal addressing, storage technologies, and processing theory. Specifically forecast are developments such as a switch from binary to decimal machines, privately owned computers, and greater use of microprogramming. A list of five references and an author-biographical sketch are provided. Details are very clear in this article, as in a dreamer's thoughts, and since many of the forecast items are geared to the year 2000, they may turn out to be dreams.

Keywords: Memories/ Compiler/ Interpreter/ Addressing/ Operating systems/ Storage/ Time-sharing/ Mini-computers/ Programming/ Binary/ Decimal/ Microprogramming/ Forecast/ Third generation/

DAN:SSA:8/23/73

Friedman, Lee A., "The Impact of Technology on the Future State of Information Technology Enterprise," in 1973 National Computer Conference and Exposition. Volume 42, (AFIPS Press, Montvale, New Jersey), 1973 AFIPS Conference Proceedings, (LC 55-44701), p. 751-757, 12 refs.

In the next 5 to 10 years certain changes will occur in the competitive market place that may affect all of those who are involved in information technology enterprise. The author here develops a technique that can help prepare for change and increase the chances of survival. Expected consumer and market demands are presented. Sometimes these demands indicate new trends and the need for new technological capabilities.

The author also reviews some of the policies that are used in business today, PROMAX (product performance maximization) and MISMAX (mission performance maximization).

The technique developed for survival in the market place is a combination of forecast-planning assessment functions and flows in this order, data base generation, forecasting, planning, assessment, commitment/decision and action, program monitoring and feedback and adjustments/additions to functions. All of the examples in this paper are for the computer industry but the author feels that his technique would apply to any technology bound enterprise and would answer questions necessary for the preparation of change and survival.

Keywords: Technological change/ Competitive market/ Market strategy/ Technological planning/

MMG:NBS:1/25/74

Fusfeld, Alan R., "The Technological Progress Function: A New Technique for Forecasting," Technological Forecasting, Volume I, 1970, p. 301-312, 28 refs.

Technological trend forecasting is generally based on a plot of technical parameters against time. This author studies a new approach of plotting technical parameters against cumulative production quantities and discusses the implications this approach has on forecasting. He introduces technological progress function as the "dependence of a technical value upon production quantities." After the function is developed empirical studies were conducted on data from the aircraft industry, the electric lamp industry and computer programming. This article should be considered when discussing methods or techniques of forecasting.

Keywords: Technological progress function/ Production quantities/ Empirical studies/

MMG:NBS:12/12/73

Gabor, Dennis, "Normative Technological Forecasting," Technological Forecasting, Volume I, 1969, p. 1-3.

This very brief article questions the rapid onslaught of technology and focuses on the expanding role of the forecaster in easing the impact of technology on all facets it touches. Normative forecasting is nothing else but the setting of desirable goals for technological research. These goals must be planned against society's needs, wants and capabilities. This article brings to the open questions which must be considered before a technology is planned or implemented.

DAN:SSA:10/31/73

Gallagher, James D., "Crystal Balling: The Corporate Computer in the '70s," Infosystems, 20:1 (January 1973), p. 24-25, 58-59.

This paper, one in a series in Infosystems on corporate data processing, has its basis on the corporate environment and new corporate options. At the beginning, predictions are made in the ADP field, 1972 through 1985, from firmware to the 'wired-city' concept. In the corporate environment, evolution is followed from the simplicity of the 50s to the complexity now resulting. The roles of the managers and technicians are evolving along with the equipment, each playing vastly different roles now than during the onset of ADP. The author sees a more user-oriented ADP environment during the 70s and along with this, he sees a maturing environment, no longer led into blind acceptance of a computer technology. The main point of the article is a maturing corporate ADP community. Forecasts are generally made on computer technology's varied concepts, but this paper studies the past and present corporate ADP environments and looks into its future, an unusual yet unique and interesting article.

Keywords: Firmware/ Wired-city/ Software/ Hardware/ Natural-language processing/

DAN:SSA:11/1/73

Glushkov, V. M., "Forecast and Control of Scientific Investigations," Joint Publications Research Service, Washington, D.C., January 8, 1971, 13 p. (Translation of Akademiya Nauk U.S.S.R., Kiev. Visnyk, Number 10, p. 52-58, 1970)

A marked rise of interest in scientific investigations and forecasting problems has been noted of late. This interest is concerned primarily with concrete predictions in the fields of science and technology as they relate to the immediate years ahead as well as to long-range forecasting. It can be explained first of all by the fact that currently there has been a sharp acceleration in the tempos of scientific-technological progress, and that planning for economic and technological development without simultaneously engaging in scientific-technological forecasting is not possible. (Author)

Keywords: Scientific-technological forecasting/ Economic development/ Scientific development/

MMG:NBS:12/12/73

Gordon, Theodore J. and Harold S. Becker, "The Cross-Impact Matrix Approach to Technology Assessment," Research Management, July 1972, p. 73-80.

This paper describes in detail the processes involved in assessment by use of the cross-impact matrix approach and follows the method from its inception to present usage. "Cross-impact analysis is based on the concept that the occurrence or non-occurrence of a possible event or the inactment of a particular policy may affect the probability of occurrence of a host of other events and policies." The main point of this article is the process involved in the use of cross-impact matrices, describing in detail both man and machine procedures, from human judgment to computerized random selection. The elements involved in construction of a cross-impact analysis are the events to be analyzed and the probabilities of an event's occurrence by a certain date. Described wholly in the article are the steps involved to arrive at a good matrix and the example used is the electric automobile. The article is a very well organized insight into cross-impact methodology.

Keywords: Cross-impact analysis/ Matrix development/

DAN:SSA:11/1/73

Gordon, Theodore J. and Robert H. Ament, "Forecasts of Some Technological and Scientific Developments and their Societal Consequences," The Institute for the Future, Middletown, Connecticut, IFF Report R-6, September 1969, 98 p.

This report is one of a total of six reports dealing with the development of advanced procedures for the long-range forecasting of technological and societal events. The goal of these studies was to see what impact future change would have on the citizens of Connecticut. The years considered were from the present (starting with 1969) to about the year 2000. A technical Delphi study was performed using panelists from all over the world. Both technological developments and social consequences of these developments were studied. Examples of the questions asked for the Delphi and the techniques of questioning used are included in this report. The summarization of the Delphi is presented as forecasts of technological and scientific developments. An extensive list of consequences occurring from the above forecasts is developed. The consequences were judged as being favorable or unfavorable.

There are a few forecasts included which are on the computer industry but most are on other scientific developments. The report is interesting, however, since it does describe the whole forecasting technique from preliminary planning and development of the Delphi to the actual forecasts derived from the results.

Keywords: Delphi/ Technological forecasts/ Societal effects/
Biological developments/ Physical developments/

MMG:NBS:1/28/74

Grabbe, Eugene M. and Donald L. Pyke, "An Evaluation of the Forecasting of Information Processing Technology and Applications," Technological Forecasting and Social Change, Volume IV, 1972, p. 143-150.

A number of technological forecasts concerned with information processing have been completed since 1964 using the Delphi method. Forecasted events from 1968-72 were evaluated by comparing forecast event dates with actual dates of occurrence as stated by experts. The results suggest that information processing technology and applications are advancing more rapidly than predicted by the forecasts. Various long-range forecasts are in general agreement. Information processing will be of increasing importance for future forecasts both as a subject and as a tool for processing data.

Keywords: Delphi/ Forecast evaluation/ Seer/

MMG:NBS:12/12/73

"Hardware Costs to Drop, Software Up: 70's Report," Computerworld, V:50 (December 22, 1971), p. 1, 4.

This periodical article is a review of Frost and Sullivan's Data Processing - Forecast 80. The article provides examples from F & S, listing F & S's predictions on hardware improvements in speed, size, and cost, and software improvements and usage. The report states that speed will improve 10-fold by 1975, 50- to 100-fold by 1982, only to be suppressed by manufacturers who fear for so quick an obsolescence of their previous hardware. In memory, F & S looks for a 50 nsec access of memories capable of up to 10 Terabits, costing close to millicents/bit. Software will increase in market usage and microprogramming and firmware will increase also in usage. For a more comprehensible look at F & S, look at Data Processing - Forecast 80, but this article can enlighten the user in a brief synopsis of F & S.

Keywords: Software/ Memory/ Storage/ Mass-memory/ Firmware/ Micro-programming/ Minicomputers/

DAN:SSA:8/10/73

Helmer, Olaf, "Long-Range Forecasting-Roles and Methods," The Institute for the Future, Middletown, Connecticut, P-7, May 1970, 6 p.

This short report presents a very good overview of the historical perspective of forecasting, the reasons for forecasting, some of the methodologies of forecasting and the role forecasting has now and will have in the future. A comparison is made of the laws governing physical sciences with the laws governing the future and the methodologies used in each area. The author reviews Delphi techniques and simulation. He feels, however, that the 'cross-impact' approach may be a better approach to forecasting, a "theoretical approach to law-like regularities in the inexact sciences." To summarize the objective of the author, "there is, in other words, a growing awareness that a great deal can be said about future trends in terms of probabilities, which can be estimated, and that these probabilities, to some extent, can be manipulated through proper planning."

Keywords: Overview/ Methodologies/ Cross-impact approach/ Goals/

MMG:NBS:3/5/74

Jantsch, Erich, "New Organizational Forms for Forecasting," Technological Forecasting, Volume I, 1969, p. 151-161.

In this paper, Jantsch projects a different direction for forecasting than normally expressed. He says "forecasts made for a specific institution must be fully integrated with forecasts for the entire relevant social system, beyond the specific environment with which the institution directly interacts," and "forecasts must emphasize the potential for continuous self-renewal of the institution for which they are made." The paper discusses forecasting the roles of institutions, organizing forecasting within an institution (with charts) as well as the scope of technological forecasting. This article is a well-organized presentation of new paths for technological forecasting.

Keywords: Joint systems/ Missions/ Integration/ Decentralized initiative/ Centralized synthesis/ Policy planning/

DAN:SSA:12/5/73

Jantsch, Erich, "Toward a Methodology for Systemic Forecasting," Technological Forecasting, Volume I, 1970, p. 409-419, 46 refs.

"The growing recognition of the systemic nature of a worldwide problematique--'the predicament of mankind'--has contributed to the current emphasis on systemic approaches to forecasting and planning, which are also necessary ingredients to the fullscale normative planning process. The development of forecasting methodology has received significant impulses from this direction as is borne out by the enrichment of approaches corresponding to a 'systemic' state of mind in forecasting, and by recent developments or extensions of older concepts in such approaches as structural models, horizontal relevance analysis, cross-impact analysis, input/output analysis, and iterative system projection, the combination of decision theory with concepts of systems effectiveness, heuristic and psychoheuristic programming, and network techniques."

The author develops his methodology for systemic forecasting by discussing various levels of forecasting. His dimensional integration of forecasting is in four levels, multidimensional, pluridimensional, interdimensional and transdimensional. Since the degree of dimensional integration is not sufficient for characterizing the applicability of forecasting approaches to the planning process he defines the 'states of mind' in forecasting, 'objective' approaches, 'subjective' approaches and 'systemic' approaches. He surveys forecasting approaches, classified by directions of forecasting (exploratory and normative) and by the 'states of mind.' This article is not of primary interest to SSA but is included since it presents another approach to forecasting.

Keywords: Multidimensional forecasting/ Pluridimensional forecasting/ Interdimensional forecasting/ Transdimensional forecasting/ Objective approaches/ Subjective approaches/ Exploratory forecasting/ Normative forecasting/

MMG:NBS:3/5/74

Jantsch, Erich, "Technological Forecasting in Perspective," Organisation for Economic Co-operation and Development, Paris, France, 1967, 413 refs.

This monograph presents a framework for technological forecasting, its organization and techniques, a description of ongoing work in the field and an annotated bibliography. More specifically the author establishes the framework for technological forecasting by discussing the correlation between research, technological innovation, technological planning, social technology and information science and technological forecasting. Techniques discussed include intuitive thinking, Delphi, analytical models, exploratory forecasting, normative forecasting, and feedback techniques. Finally the author discusses organizations involved in forecasting, including a writeup of each organization, consulting firms, institutes, military organizations, national organizations and international organizations. This monograph is considered a classic in the field of technological forecasting and is a must for any collection in this area.

Keywords: Technological planning/ Normative forecasting/ Forecasting methods/ Feedback techniques/ Forecasting organizations/

MMG:NBS:12/3/73

Jones, Martin V., "A Comparative, State-of-the-Art Review of Selected U.S. Technology Assessment Studies," The Mitre Corporation, McLean, Virginia, M73-62, May 1973, 92 p.

This paper provides a case-study tape survey as to how technology assessment has been conducted in the United States. In this survey, thirteen representative technology assessment studies have been compared relative to: (1) the types of organizations that participated in the conduct of each study, (2) the managerial approach used to organize and monitor the assessment project, (3) the groundrules that governed the study effort, (4) the types of impacts assessed, (5) the data collection procedures employed, (6) the methods used to analyze and interpret these data, (7) the presentation techniques used to describe the project's findings, (8) the outcome of each study.

The paper is of interest to SSA for some of the assessment techniques which were used. However, most of the thirteen technology assessment studies were interested in social and environmental implications of technology more than the state of the future technology.

Keywords: Assessment comparisons/ Technology assessment survey/

MMG:NBS:2/5/74

Jones, Martin V., "A Technology Assessment Methodology. Project Summary," The Mitre Corporation, McLean, Virginia, MTR-6009, June 1971, 30 p. (PB 202778-07)

"This paper summarizes the findings of an exploratory technology assessment project jointly sponsored by the Office of Science and Technology, Executive Office of the President, and the MITRE Corporation. The objective of the project was to develop an analytical framework and a structured procedure that could be used for anticipating the societal impacts of major technologies. Detailed findings are reported in six volumes." The main volume that is of interest to SSA is the volume titled, "Computer-Communications Networks." (See separate entry under O'Neill, Hugh V.) The other volumes are on automotive emissions, enzymes, mariculture and water pollution. This project was a good one and well worth studying.

Keywords: Technological impact/ Societal impact/ Technological forecasts/

MMG:NBS:1/24/74

Jones, Martin V., "A Technology Assessment Methodology. Some Basic Propositions," The Mitre Corporation, McLean, Virginia, MTR 6009, Volume I, June 1971, 286 p., 85 refs. (PB 202778-01)

This is one of the six reports on the subject of technology assessment prepared by MITRE for the Office of Science and Technology, Executive Office of the President. The purpose of this project was to develop a standard, structured method for making studies directed toward anticipating and influencing the societal impacts of new technology applications. This volume describes the standard methodology that was developed. The other volumes are "pilot" assessment studies covering particular fields of technologies that were conducted to help test, develop and illustrate the standard assessment methodology.

Since this volume explains the methodology used for the assessment of computer-communication networks (see entry under O'Neill, Hugh V.) it would be of secondary interest to SSA.

Keywords: Assessment methodology/ Standard methodology/

MMG:NBS:2/7/74

Judd, Robert C., "Use of Delphi Methods in Higher Education," Technological Forecasting and Social Change, Volume IV, 1972, p. 173-186, 29 refs.

This paper is concerned with describing the principal uses of the Delphi method in higher education. These areas of use are found to be (1) searching out goals and objectives, (2) campus and curriculum planning, and (3) development of evaluation criteria. Important to understanding the use of Delphi in a higher education setting are the methodological adaptations that have been employed. Delphi as used in technological forecasting requires modification when used in the generation and assessment of goals. Three principal problems in methodology are examined here. They are (1) selection of the panel, (2) the character of round one, and (3) the consequences of feedback. (Author)

Keywords: Panel selection/ Feedback/ Curriculum planning/ Evaluation criteria/

MMG:NBS:12/13/73

Kane, Julius, "A Primer for a New Cross-Impact Language - KSIM," Technological Forecasting and Social Change, Volume IV, 1972, p. 129-142, 2 refs.

A new methodology language has been developed which serves to make available the workings of cross-impact analysis available to a much larger audience in that no technical sophistication is required to become expressive in the new language. Unlike the procedures developed by Gordon, et al our methods stress the structural dynamics of the system, the geometry of the linkages rather than refining arithmetic estimates of future probabilities. However, while qualitatively and subjectively oriented, our procedures can be easily expanded to any degree of precision, providing the data and mechanisms are sufficiently well known. The key feature of our approach is that it allows one to work with data of any level - from subjective estimates to highly precise physical measurements - and the computer has the character of logical projections of basic hypotheses rather than dogmatic imperatives which is the nature of much of present social, economic, technological, and ecological modelling. (Author)

Keywords: Methodology language/ Cross-impact analysis/ Structural dynamics/

MMG:NBS:12/13/73

Kheinman, S., "Methodological Problems of Long-Range Forecasting," Joint Publications Research Service, Washington, D.C., November 23, 1970, 19 p. (translation of Voprosy Ekonomiki (U.S.S.R.) Number 10, p. 15-28, 1970).

The document considers long-range forecasts of the development of production and the economy and of science and technology which are finding broader and broader application in the developed countries of the world. Being the linking element between the forecast and the plan, the economic-political and scientific-technological concepts of a plan are based on the analysis and genetic assessments of forecasts and simultaneously define the main aspects of the perspective plan. (Author)

Keywords: Long-range forecasts/ Production development/ Economics/ Economic-political forecasting/ Scientific-technological forecasting/

MMG:NBS:12/14/73

Kiefer, David M., "Assessing New Technology," Journal of Chemical Documentation, 11:4 (November 1971), p. 210-215.

In this article the author presents a general discussion of technology assessment and its impact upon society. He discusses the reasons for assessing new technology and some of the current efforts in the field including Congressional efforts. The article does not address technology assessment of any area but does address the pros and cons of assessing new technology in general. Some of the subsections of the paper are monitoring and forecasting new technology, social change and national goals, present status of technology assessment, problems of bias and credibility, roles for industry and government and assessing the assessment process. Because of its generality this article has little of interest to SSA.

Keywords: Technological assessment/ Social impact/ General discussion/

MMG:NBS:2/4/74

Kohl, Walter H., "Assessment, Transfer, and Forecasting of Technology," IEEE Spectrum, 8:1 (January 1971), p. 70-75, 46 refs.

"The social implications of our rapidly developing technology must be brought to the attention of public policy makers if we are to achieve our social goals in a rational manner." This is the main point that the author is trying to make in this article, that technology needs to be managed so that as technology expands society does not have to just survive as best it can. Technological forecasting or assessment can be a tool for planning the future.

He discusses the terminology used such as technology assessment, control, transfer and forecasting. He mentions work that has been completed in the past and work that is ongoing on forecasting. Special emphasis is on the ongoing work of policymaking institutions such as the federal government. No application areas for forecasting are given nor actual forecasts included. The main reason that SSA would be interested in this article is to see what other organizations in the federal government are involved in programs on technological forecasting.

Keywords: Technology assessment/ Technology transfer/ Managing technology/ Social implications/ Policy issues/

MMG:NBS:2/5/74

Kovac, F. J. and M. F. Dague, "Forecasting by Product Life Cycle Analysis," Research Management, July 1972, p. 66-72.

Using tires as an example, the authors describe how future projections can be made based on the principle that the life (in terms of demand) of many products from their birth in the R & D Departments until their decline years later in the market place, takes the form of an S-curve. Five steps in the process of the S-curve are outlined; 1. Experimentation and Development (little growth); 2. Commercialization (up to 10% growth per year); 3. Growth (3-10% growth per year); 4. Maturity (0-3% growth per year), and; 5. Decline. All are presented concisely, along with a market analysis with relation to product growth, all using tires as the market-product example. This article, although short and thorough, is not applicable to forecasting in the technologies.

Keywords: Projections/ Market analysis/ Product growth/

DAN:SSA:11/1/73

Kurakov, I. G., "Forecasting Scientific and Technical Progress," Wright-Paterson AFB, Ohio, Foreign Technology Division, Report No. FTD-MT-24-234-70, January 29, 1971, 31 p. (Edited Machine Translation of Voprosy Filosofii (U.S.S.R.), 22:10, p. 21-35, 1968 by Bernard L. Tauber).

The article seeks to analyze the relation between an increase in the level of industrial knowledge and an increase in the productivity of labor. By means of formulas and graphs, it attempts to determine that portion of the increase in production funds which should be expended on the improvement of industrial knowledge. Comparisons with similar expenditures in non-communist countries are made. The ultimate goal is the development of an analytical tool for forecasting industrial growth. (Author)

Keywords: Industrial growth/ Labor productivity/ Industrial knowledge/

MMG:NBS:12/12/73

Leclercq, Rene, "The Use of Generalized Logic in Forecasting," Technological Forecasting and Social Change, Volume II, 1970, p. 189-194, 5 refs.

The author has prepared a formalization of all the forms of logic used in forecasting, including, analogy, generalization, induction, abstraction and deduction. In this article he presents the specific use of this logic in forecasting and the application of a new forecasting and the application of a new theory of solutions. The formalizations of the various forms of logic are summarized in this article (the full formalization is given in another publication) and a few applications of generalized logic to forecasting made including global forecasts vs. partial forecasts, the variation of the value of the forecast and solutions to relevance trees or lattices. The article is a purely theoretical one consisting mainly of proofs and would be of no use to the lay reader but would to someone trying to prove some of the logic used in forecasting.

Keywords: Formalization of logic/

MMG:NBS:12/12/73

Martin, William Tell and James M. Sharp, "Reverse Factor Analysis: A Modification of Relevance Tree Techniques," Technological Forecasting and Social Change, Volume IV, 1973, p. 355-373, 4 refs.

This paper uses techniques of factor analysis to develop an algorithm for manipulating the issues-criteria matrices found in relevance trees. The new procedure provides a general framework that overcomes specific methodological shortcomings of a widely discussed tree scheme, PATTERN, as well as providing increased internal consistency in any relevance tree format. An example from urban policy decision making demonstrates the algorithm's versatility. (Author)

Keywords: Algorithm/ Issues-criteria matrices/ PATTERN/

MMG:NBS:12/17/73

Martino, Joseph P., "Correlation of Technological Trends," Technological Forecasting, Volume I, 1970, p. 347-354.

There are many technologies which seem to follow another technology, i.e. two technologies which appear to have a precursor-follower relationship. If the relationship is a valid one then knowledge of the behavior of the precursor technology can be used to predict the behavior of the follower technology. The author establishes a method to be used in the above case. His example is the case of the speeds of combat aircraft and transport aircraft. An interpolation is made between the actual events in one technology. The precursor technology and a logged trend equation formulated. Once the trend correlation is developed the forecast can be made for the follower technology. Since a number of events in the computer industry seem to follow one another this method should be of interest.

Keywords: Trend correlation/ Lagged trend equation/ Precursor-follower relationship/ Time lags/

MMG:NBS:12/12/73

Martino, Joseph P., "An Introduction to Technological Forecasting," The Futurist Library, Volume I, Gordon and Breach Science Publishers, New York, 1972, 108 p.

This book presents a general introduction to the area of technological forecasting. It tries to define forecasting, indicate application areas and give a general indication of how forecasting is used. It is not a highly technical work giving descriptions of how to make forecasts nor is it a book meant to be entertaining with awesome visions of the future. The aim of the book is to show that technological forecasting is a tool to help make the right decisions for the future not just to predict what the future might be.

Several authors' papers are included in the collection. After a general introduction to forecasting a couple of papers are included on methodologies such as Delphi and then applications areas are discussed including, forecasting and space exploration, forecasting for military management, industrial implications and social implications.

Even though this book is a few years old and some of the papers included still older it nevertheless has a place as an introduction or tutorial on forecasting and should be one of the first books for a newcomer to the field to consider reading.

Keywords: General descriptions/ Technological implications/ Delphi/ Space exploration/ Military management/ Industrial implications/ Social implications/

MMG:NBS:1/24/74

Martino, Joseph P., "Examples of Technological Trend Forecasting for Research and Development Planning," Technological Forecasting and Social Change, Volume II, 1971, p. 247-260.

Existing means of technological forecasting were evaluated and the methods used were examined for improvement. This article "presents the results of fitting appropriate trend curves to several sets of data on technologies of interest to the Air Force." Technological forecasts are made when the trends are projected. "The likelihood of continuation or change of the trend is discussed in each case, with implications for R&D (research and development) planning. These forecasts are considered of possible interest as examples of applied forecasting techniques." The article is of interest to anyone applying forecasting for research and includes many examples which show how this was done. It would be a good reference. Forecasts include: fighter aircraft weight, combat aircraft speed, aircraft engine power, rocket engines and transport aircraft productivity.

Keywords: Technological forecasts/ Air Force applications/

MMG:NBS:12/12/73

Martino, Joseph P., "The Lognormality of Delphi Estimates," Technological Forecasting, Volume I, 1970, p. 335-358, 2 refs.

This short article is intended to show that the Delphi procedure is not a chaotic process but is "a well-behaved process which can be described quantitatively." The author utilizes estimates made as part of a Delphi forecast at TRW. The first round estimates are standardized by subtracting the mean value and dividing by the standard deviation for that question. Using this method the resulting distribution was plotted on lognormal coordinates. The good fit to a straight line shows that the estimates were lognormally distributed. A good fit was obtained for the cumulative probability distribution of standardized deviates for 10%, 50% and 90% likelihood estimates. The good fits seems to indicate that the Delphi process is a well-behaved process.

Keywords: Cumulative probability/ Standard deviation/ Lognormal plotting/

MMG:NBS:12/12/73

Martino, Joseph P., "The Precision of Delphi Estimates," Technological Forecasting, Volume I, 1970, p. 293-299, 5 Refs.

Several Delphi forecasts were collected for evaluation. A systematic study was made of Delphi panel estimates as a function of remoteness of the panel estimate of the event. Forecast dates and the dispersion for each event were extracted from the forecast or calculated based on other material in the forecast. The regression of the panel on the length of the forecast was obtained. The following results were given for each set of forecasts by a panel, the number of events, the correlation coefficient, the regression coefficient and the statistical significance of the regression coefficient. The statistics show that there is an increase in uncertainty in the estimates as the forecast events become more remote. This article is only of interest as it relates to the authenticity of the Delphic process for developing technological forecasts.

Keywords: Delphi/ Evaluation/ Delphi panel/ Regression coefficients/ Correlation coefficient/

MMG:NBS:12/12/73

Martino, Joseph Paul, "Technological Forecasting for Decisionmaking," American Elsevier Publishing Company, Inc., New York, 1972, 750 p.

The emphasis of this book is on the use of technological forecasts for decisionmaking purposes. Three major areas are covered; methods of technological forecasting including delphi, forecasting by analogy, growth curves, trend extrapolation, analytical models, and normative methods; applications of technological forecasting including planning and decisionmaking, research and development, technology advancement, product development, business decisions, government decisions and social decisions; and ways that a forecaster can improve his product so that it is more useful for decisionmaking. A final discussion is included on the future of technological forecasting.

This book is not a general text on forecasting but is on the application of forecasts for decisionmaking. For these purposes it is most useful.

Keywords: Delphi/ Analogy/ Growth curves/ Trend extrapolation/ Analytical models/ Normative forecasting/ Technological planning/ Time series regression analysis/

MMG:NBS:12/3/73

McCusker, Tom, "Computers in the '70's," Datamation, 16:6 (June 1970), p. 157, 159.

This article is a report of a symposium held at UCLA in the spring of 1970. It produces some forecasts in intangible ADP (programmers, education, privacy), applications (medicine, banking, communications), and hardware by people involved with ADP. Much is said of the "people" problem, (e.g., "It was the people problem . . . that killed the full use of optical character recognition"), but no definite solution is given, although it is pointed out that ADP will become more user-oriented in the 70s. Software ("market will triple"), information systems (evolution from art to science) and enter-ADP-shop communications problems ("communications is ineffective, non-standard, and often beset by emotional and psychological conflict") are the main topics of the article. Although over 3 years old, the article still provides insight into the 70s and even somewhat further into the 80s on subjects which are here and now problems and events in ADP.

Keywords: Applications/ Hardware/ Personnel/ OCR/ OMR/ Software/ Information systems/ Communications/ Data banks/

DAN:SSA:8/10/73

Mitroff, Ian I. and Murray Turoff, "The Whys Behind the Hows. Effective Application of the Many Forecasting Methods Requires a Grasp of Their Underlying Philosophies," IEEE Spectrum, March 1973, p. 62-71.

It is the authors' belief that "the effective application of the various methodologies of technological forecasting and assessment requires understanding the philosophical underpinnings of these methodologies." Technological forecasting can never be a purely technical or scientific endeavor but will always retain a basic philosophical element. The main purpose of the article is to point out the fundamental differences of various forecasting methodologies so that a desired approach may be more easily selected. The philosophies studied include Leibnizian, Lockean Kantian, Hegelian and Singerian. These philosophies represent the inquirer approach to such techniques as simulation, correlation analyses, regression analyses, Delphi, trend extrapolation, normative forecasting and scenarios.

A study is also made of the structure of forecasting or the six basic types of information considered in a forecast, feasible technological developments, potential applications, significant applications, potential consequences, policy or resource allocation issues and potential resolutions of issues. The article is well written and unique in its subject matter. It is well worth consideration for SSA.

Keywords: Liebnez/ Locke/ Kant/ Hegel/ Singer/ Forecasting philosophies/ Methodologies/ Forecasting structure/

MMG:NBS:3/8/74

National Academy of Engineering, "A Study of Technology Assessment," Washington, D.C., Committee on Public Engineering Policy, July 1969, 208 p.

This report is the result of an agreement of the Committee on Science and Astronautics with the National Academy of Engineering to study possible techniques to be applied in areas of technology assessment. The following quotation summarizes the findings. "First of all, we now feel that useful methodologies are available for technology assessment and that more adequate ones can be developed through practice. Second, our experiences show that task forces of experts specifically constituted for particular technology assessments can accumulate data and develop insight on the potential impacts of technology on society. Third, our preliminary work shows that such task forces can propose a variety of national strategies for modulating the effects of technology on society, thereby providing the legislator with a better base for his judgments on the role of government in influencing technology." It is hoped that in the 1970's "the practice of technology assessment could provide a more productive framework for decisions about the appropriate utilization of technology for social purposes."

This reference is included in the data base to show some of the work sponsored by Congress and to show what some of the recommendations are for Congress on technological assessment.

Keywords: Congressional role/ Federal government/

MMG:NBS:3/1/74

National Academy of Sciences, "Technology: Processes of Assessment and Choice," Washington, D.C., Committee on Science and Public Policy, July 1969, 163 p., 54 refs.

This is the third report submitted to Congress under an agreement of the Committee on Science and Astronautics with the National Academy of Sciences to produce study and pilot programs designed to isolate and describe some of the critical policy issues which government must consider in its decisions to regulate, support or otherwise foster research in the United States. This report is also the final report of the Ad Hoc Panel on Technology Assessment, created by the Committee on Science and Public Policy.

One of the issues of this report is the organization of a possible technology-assessment structure within the Federal Government. The pros and cons of each view point are discussed. The Ad Hoc Panel wanted to study the lessons learned from past efforts at technology assessment and from failures to anticipate the impact of emerging technologies. A large amount of case material was collected. However the main thrust of this group was on the structuring of the problem and on the design of an organizational framework for technology assessment in the Federal Government.

This reference is included in the data base to indicate some of the objectives of the Federal Government in the field of technology assessment.

Keywords: Technology assessment/ Federal government/ Roles and objectives/

MMG:NBS:3/1/74

National Materials Advisory Board (National Academy of Sciences - National Academy of Engineering), "Technological Forecasting and Its Application To Engineering Materials," Washington, D.C., Contract DA-49-083-OSA-3131, Final Report 1969-1971, Report No. NMAB-279, March 1971, 54 p. (AD-726-221).

The major value of technological forecasting is in its contribution to planning and decisionmaking. Among the benefits possible from engaging in a forecast of technical opportunities in materials are: use of advanced materials technology, simplifying the selection of appropriate materials areas, identifying areas of most productive interdisciplinary activity, expanding the horizons of involved individuals, identifying roadblocks and new approaches to provide a better basis for decision-making, and reducing the possibility of surprise. (Author)

Keywords: Planning/ Decisionmaking/ Materials technology/ Scientific research/

MMG:NBS:12/12/73

Office of Aerospace Research, "Approaches to Long Range Forecasting," Arlington, Virginia, April 1969, 155 p. (AD-717 387), (Presented at the Symposium on Long Range Forecasting and Planning (3rd) held at Alamogordo, New Mexico on 29-30 April 1969).

This report contains the following: simulating alternative economic futures; forecasting military requirement: a critical viewpoint of the industry's approach; election night forecasting; forecasting highway demand; technological forecasting in an R&D laboratory; producing the first Navy technological forecast; forecasting international relations--a proposed investigation of three-mode factor analysis; and forecasting solar events.

Keywords: Economic predictions/ Military requirements/ Election prediction/ Highway demand/ R&D planning/ Navy technological forecasting/ Factor analysis/ Solar predictions/

MMG:NBS:12/12/73

O'Neill, Hugh V., "A Technology Assessment Methodology. Computers--Communications Networks," The Mitre Corporation, McLean, Virginia, MTR 6009, Volume 3, June 1971, 236 p., 72 refs. (PB 202778-03)

This paper describes a Pilot Computer Technology Assessment Study. This study has as its goal the development and illustration of technological assessment methodology and in addition, as a secondary objective, the investigation of certain salient segments of the general computer situation. This study, a MITRE funded and supported effort, is one of a set of six studies that MITRE recently completed on the subject of technology assessment. This report includes: a summary; task definitions; technology descriptions; state of society/universe assumptions, attributes, and conditions; relevant impact areas; initial impact analysis; action options and recommendations for future research and development programs; forecasts/projections, uncertainty and analysis of future impacts; and, conclusions and recommendations. It should be of primary interest to SSA. The time frame of the study is from approximately 1965 to 1985.

Keywords: Technology description/ Technological forecasts/ Social implications/

MMG:NBS:1/24/74

Parsons and Williams, Inc., "Forecast 1968-2000 of Computer Developments and Applications," Copenhagen, Denmark, 1968, 60 p.

This reference reports a long-range forecast based on an intuitive forecasting technique (Delphi). The participants of File 68, an international seminar on file organization held in Denmark in November 1968 answered two questionnaires and Parsons and Williams coordinated the results. This report includes copies of the questionnaires, some of the comments of the respondents, the results of the forecast, description of the forecasting method and the summary and conclusions of the findings.

Some of the findings for the year 2000 include, greater influence of computers on society, 50% reduction of the labor force in present industries, major industry control by computer, totally automated money and check systems, controlled traffic flow and automobile auto-pilots, greater use of computers in medicine and all other sciences, computers in the home, large networks, laser memories, pocketsize computers, oral input, laser communications, computers learning from their own experience, and a decrease of computer prices by a factor of 100. This report is well worth studying and has much information pertinent to the needs of SSA.

Keywords: Technological forecasts/ Hardware/ Software/ Social impact/ Networks/ Laser memories/ Communications/ Manufacturing control/ Self-learning computers/

MMG:NBS:3/1/74

Rabitsch, Elisabeth K., "Input-Output Analysis and Business Forecasting," Technological Forecasting and Social Change, Volume III, 1972, p. 453-463, 9 refs.

This paper reviews the data sources available to business forecasters and planners through the Office of Business Economic's input-output study (provides a data base to arrive at up-to-date estimates, and forecasts, of the input-output relationships of major industrial sectors in the U.S.) and some input-output projects which are now in progress in the U.S. It examines the "use of input-output tables to assess the short-term impact of economic events, and to estimate the effect of long-term structural and technological changes on economic growth." Also included is a discussion on the "application of the input-output concept to business forecasting and planning."

Keywords: Economic growth/ Industrial sectors/ Business planning/

MMG:NBS:12/12/73

Rice, R., "The Impending Revolution in Computer Technology," in 1958 Proceedings of the Eastern Joint Computer Conference, (American Institute of Electrical Engineers, New York, New York), July 1959, p. 43-46.

This article is a chronological description of the major events in computer technology and an extrapolation of what is to come. The steps described are relay logic, tube logic, transistor logic, and into the future with cryogenic elements. Illustrations are included to each step and graphs are used to explain switch time comparisons and the limits of present-day technologies. For an article on logic developments over the history of computers, this one is excellent, but logic is its only topic and more is said of what has occurred than what will occur.

Keywords: Logic/ Transistor/ LSI/ Relays/ Memory/ Storage/ Registers/

DAN:SSA:9/14/73

Riley, Wallace B., "Wanted for the '70s: Easier-to-Program Computers," Electronics, 44:19 (September 13, 1971), p. 61-84.

This large article discusses the improvements likely to occur during the 70s. It relates each new improvement to its predecessor problem of the 60s. Stressed in the article were software improvement; ranging from more user-oriented software packages to a replacement of software with hardware, or the combination of both, called firmware. Also dealt with heavily were new-system concepts evolving in the 60s and 70s, which will rise in usage, such as modular systems, pipeline and parallel processing systems. Technological improvements in memories are heavily detailed, while peripheral equipment is done over lightly in comparison. Also forecast by the author is a concept analogous to the spread of automobiles: By 1980, we will be as dependent on the computer as we are now on the car; where we'll find we don't like it (e.g. smog) but we can't do anything about it.

Included in the format of the article are various small papers on: Software; "Toward Better Software," Jack Goldberg (and references); the future effect of computers on society; "Slotnick on Computers and Society,"; the big machines; "Hopper Against the Big Machine," "Thornton for the Big Machine"; and forecasts in computer technology; "Eckert on Making Haste Slowly" and "Two Views from the Top Company."

This article holds much, in fine detail with some backtracking for concept definition and problem definition, to both the technical and lay readers.

Keywords: Technological/ Forecasting/ Future/ Hardware/ Software/ Memories/ Parallel/ Pipeline/ Firmware/ Semiconductor/ LSI/ Modular/ Distributed/ Mini-computer/ Processor/ Peripherals/ Laser/ Holographic/ Programming/ Languages/

DAN:SSA:8/23/73

Roberts, Edward P., "Exploratory and Normative Technological Forecasting: A Critical Appraisal," Technological Forecasting, Volume I, 1969, p. 113-127.

This article is a very detailed analysis of exploratory and normative technological forecasting. Along with analyzing technological forecasting in systems terms and effectiveness, much is done in explaining the disciplines of technological forecasting. The author divides economic forecasting (an already progressed discipline of forecasting) into six steps: Wisdom or Genius forecasting; "Naive" models; Simple correlative forecasting models; Complex multivariate econometric forecasts; Dynamic causally-oriented models; and, Learning models. He parallels technological forecasting to this, concluding that technological forecasting is in step three, simple correlative forecasting models, having gone through wisdom and genius forecasting, (although this is still heavily used in the shapes of Delphi and Seer) and "naive" models (now employed in trend extrapolation). Four systems are used as examples: PROFILE, QUEST, PATTERN, and PROBE, all in the government or on government contracts. Four drawbacks are identified in current systems: costliness, dubious accuracy, inflexibility, and limited impact. The author concludes by noting the best technological forecasting system would integrate exploratory and normative forecasting methods, all using dynamic system models. The article is conclusive and concise, suggesting approaches for a better forecasting discipline and explaining technological forecasting methodology.

Keywords: Economic forecasting/ Normative/ Exploratory/ DELPHI/ SEER/ PROFILE/ QUEST/ PATTERN/ PROBE/ Models/ Dynamic systems models/

DAN:SSA;12/5/73

Rochbert, Richard, "Information Theory, Cross-Impact Matrices, and Pivotal Events," Technological Forecasting, Volume II, 1970, p. 53-60.

This article reports on preliminary works toward developing analytic criteria which would allow the selection of the important events from a long list of possibly important events. The criteria consider the importance of an event, the extent to which one event influences others and the importance of the events being influenced. The author's approach "uses the data of a cross-impact matrix and relevance multipliers, and allows the events in the matrix to be rated according to how pivotal they are and how much relevant information would be obtained if their occurrence were decided." The author describes his approach and presents an analysis of the methodology. He does not discuss the application of the approach in specific case studies.

Keywords: Selection criteria/ Event importance/ Relevant information/

MMG:NBS:12/12/73

Rolnick, Leonard S., "The Technology Race of the 70's," in DPSA Input/Output Systems Seminar 71, (Data Processing Supplies Association), 1971, p. 2-9.

This article is the text of the keynote speech at the Data Processing Supplies Association (DPSA) Input/Output Systems Seminar 71 and is geared to the marketplace primarily. The aim of the speech is toward input/output and states that those companies which can foresee the technological needs of the future will profit most. Highlighted in the speech are OCR, OMR, keypunch, keyplex and other I/O methods. The author declares that an evolutionary program of standardization and development of lower cost equipment are necessary for full expansion of OCR in the market. Also discussed are OMR, minis, and forms, but the article is directed toward the market of the I/O material and how best can it be sold. Although geared to the seller, this article can provide some useful information about the problems of data entry to the user.

Keywords: Input/ Output/ Display/ OCR/ OMR/ Keyboard data entry/ Minicomputers/ Forms/

DAN:SSA:11/1/73

Salancik, J. R., William Wenger and Ellen Helfer, "The Construction of Delphi Event Statements," Technological Forecasting and Social Change, Volume III, 1971, p. 65-73.

The objective of Delphi is to gather a consensus of opinions from a group of respondents. Usually the opinions are on the occurrence of some future event. Since the opinions of the respondents may vary with the form of the question, it is imperative that the description of the future events be carefully structured. This paper discusses methods of constructing these event statements, problems involved with these statements and possible solutions. The article would be of interest to anyone attempting to use the Delphi method for forecasting.

Keywords: Delphi/ Structuring/

MMG:NBS:12/12/73

"The Shape of Things to Come," Automatic Data Processing Newsletter, XVII:1 (January 8, 1973), p. 1-4.

This short article describes some anticipated developments for the year 1973 and evaluates what the trends for the computer industry itself may be. The ADP Newsletter considers 1973 as the beginning of a "new era in computing" in which the user has the power to get what he wants and not what the computer experts have decided he wants. Specific areas such as virtual memory, ADP spending, data processing personnel, data communications, minicomputers, word processing and legal trends are discussed. Each section is quite short and only gives a summary of the present and a general indication of the next year.

Keywords: Computer developments/ 1973/

MMG:NBS:1/31/74

Stevens, Mary E., "Selected R&D Requirements in the Computer and Information Sciences," in 1970 Fall Joint Computer Conference, Volume 37, (AFIPS Press, Montvale, New Jersey), 1970, AFIPS Conference Proceedings, (LC 55-44701), p. 159-168, 44 refs.

This article outlines the R&D requirements, as researched by the Center for Computer Sciences and Technology at the National Bureau of Standards, in the communications and teleprocessing fields. This complex yet informative article, through flowcharts and much outlining of important areas, presents major areas of concern, both continuing and possible, problems in communications: man-man, man-machine, and machine-machine, and discusses possible solutions. Aspects of computer technology discussed include information storage and retrieval, input and output and LSI technology. Much is discussed here with respect to the fields of which interrelate with society as a whole and society as individual men.

Keywords: Communications/ Storage/ Retrieval systems/ LSI/ Memory/ Input/ Output/ Teleprocessing/

DAN:SSA:9/21/73

Stuart, Spencer R., "Crystal Balling: New Challenges for Chief Executives," Infosystems, 20:1 (January 1973), p. 22, 66-67.

In this part of the "Crystal Balling . . ." series the author discusses what the roles of data processing management will be in the future. He feels that "the tremendous technological growth which will occur in the next five years will result in major problems for management." Three major changes need to be made to meet the challenges of the future. First there needs to be a new group effort in management, a working management team. Second, management must consistently be renewed and updated. As technology grows, so must the managers of the technology. And finally, young talent must be attracted to the business.

The author discusses the reasoning behind his choosing these three major challenges and also some of the steps necessary to face these problems. Since SSA has a large data processing area to manage, this article should be most interesting.

Keywords: Management objectives/ Management team/ Management renewal/ Management motivation/

MMG:NBS:1/31/74

"The Supersonic Seventies - Technology," Business Automation, 17:1 (January 1970), p. 45-47.

This article attempts to show the changes which will occur within ADP during the 1970s. Based on an Arthur D. Little, Inc. survey, the paper describes a slower pace in technological development but less-than-dramatic improvements in circuit and memory cost performances and a software surprise. Forecast within are ten-fold cost-performance improvement of memories, significant trends in large-scale processor organization, more changes occurring in system architecture, significant bit-density improvements and a continuing dominance of magnetic storage media during the decade. Examples used are the Illiac IV parallel-processing system and the pipeline system of the STAR. The survey/article tends to dwell on generalities within the ADP field, excluding entirely minicomputers and most of data entry.

Keywords: Memory/ Central computers/ System architecture/ Magnetic media/ Parallel processors/ Software/

DAN:SSA:8/9/73

Swager, William L., "Summary of Technological Forecasting Seminar, Battelle Seattle Research Center, November 5-7, 1969," Technological Forecasting, Volume I, 1970, p. 359-361.

The purpose of this article is to summarize the highlights of the seminar mentioned in the title. The participants were encouraged to criticize available methods for technological forecasting and planning, to look for relationship among the various approaches and to look for goals for the development of new methods. Most of the participants work actively in the field of forecasting but a few were also from the fields of physical sciences and social sciences. Highlights of the various papers are presented and general conclusions that came out of the conference are outlined. This article does not contain any of the technical contents of the papers presented but does give some general opinions on forecasting which would be of interest.

Keywords: Seminar highlights/ Seminar summary/

MMG:NBS:12/12/73

Turn, Rein, "Air Force Command and Control Information Processing in the 1980s" Trends in Hardware Technology," Rand Corporation, Santa Monica, California, Contract No. F44620-67-C-0045, Rept. No. R-1011-PR, October 1972, 229 p.

"This report estimates the technical characteristics and capabilities of data-processing systems, subsystems, and components that are likely to be available or that could be developed for Air Force command and control system applications in the 1980s." The methodology used is trend extrapolation or what they call a "surprise-free" technological forecasting which provides results that do not depend on future technological breakthroughs for their validity. Trends are given for general-purpose computer systems (CPU, memory, input devices, data communications, programming aspects, characteristics, costs) and computers in command and control systems (ground-based, airborne, spaceborne, special-purpose). Technological analyses are studied for the following areas: processors, random-access memories, mass memories, wideband recording display and input-output devices, maintenance, vulnerability for command, control and communications equipment and innovation. The forecasts given are interesting but are limited by their application to the Air Force and by the methodology chosen for creating the forecasts.

Keywords: Trend extrapolation/ Technological forecasts/ Command and control systems/ Processors/ Memories/ Preipherals/ Communications equipment/

MMG:NBS:12/12/73

Turoff, Murray, "An Alternative Approach to Cross Impact Analysis," Technological Forecasting and Social Change, Volume III, 1972, p. 309-339, 43 refs.

This paper presents the theoretical justification for the use of a particular analytical relation for calculating inferences from answers to cross impact questions. The similarity of the results to other types of analogous applications (i.e., logic regression, logistic models, and the Fermi-Dirac distribution) is indicated.

An example of a cross impact analysis in an interactive computer mode is presented. Also discussed is the potential utilization of cross impact as: (1) A modeling tool for the analyst, (2) A consistency analysis tool for the decision maker, (3) A methodology for incorporating policy dependencies in large scale simulations, (4) A structured Delphi Conference for group analysis and discussion efforts and (5) A component of a lateral and adaptive management information system. (Author)

Keywords: Theoretical justification/ Cross impact questions/ Applications/

MMG:NBS:12/12/73

Turoff, Murray, "Delphi Conferencing: Computer-Based Conferencing with Anonymity," Technological Forecasting and Social Change, Volume III, 1972, p. 159-204.

This lengthy article is a report of an experimental conference held for thirteen weeks in the Spring of 1970. Each individual participating was allowed to go to a terminal at any time to engage in the conference discussion. (The participants were located throughout the country.) A computer kept account of the discussion items entered by the participants and how they had voted on various items. Since the computer did not let the participants know the identity of the other participants nor the originators of the items nor how any other participants voted, the system may be known as a "Delphi Conferencing System". The purpose of the conference was to evaluate potential applications of this type of conference and to study the author's design of the particular system in use. The article presents a very interesting application of the Delphi methodology and also an interesting new approach to conferencing. It is filled with the actual questions and answers used for the conference.

Keywords: Delphi conferencing system/ Conference communications/

MMG:NBS:12/12/73

Turoff, Murray, "The Design of a Policy Delphi," Technological Forecasting and Social Change, Volume II, 1970, p. 149-171, 99 refs.

"The purpose of this paper is to offer some suggestions and ideas to anyone interested in designing, utilizing, or participating in a Delphi devoted to examining policy issues. A policy issue is defined, for the purposes of this paper, as an issue for which rational individuals advocate differing resolutions." The author suggests that a Delphi for policy issues may serve as an addition to the committee approach to policy formulation. "a conjunction of the two methods may eliminate a good many of the disadvantages of both." After a general discussion of the Delphi technique the author discusses the role of the policy Delphi, the dangers involved, consideration of implementation and material for the respondents. A large bibliography is included with a general discussion of ongoing use of Delphi in other areas. This is a good article for anyone planning to use Delphi for policy planning.

Keywords: Policy planning/ Delphi techniques/

MMG:NBS:12/12/73

Turoff, Murray, "Meeting of the Council on Cybernetic Stability: A Scenario," Technological Forecasting and Social Change, Volume IV, 1972, p. 121-127, 8 refs.

A fictional format is used to focus on the issue of the use of scenarios. Scenarios have been used in technological forecasting for summarizing the results of involved studies. These scenarios may be known as positive ones. There are also negative scenarios, where certain trends and situations are extrapolated to the extreme case. These scenarios highlight problems and therefore lower the rate of these problems occurring. Since the use of scenarios seems to have more and more importance to long range planners, the author felt they needed to be studied. Since they are a useful tool in forecasting, this article is of some interest to SSA.

Keywords: Scenarios/ Humorous study/

MMG:NBS:3/5/74

Turoff, Murray, "Session on Views of the Future--Chairman's Introduction--Opposing Views," in the 1973 National Computer Conference, Volume 42, (AFIPS Press, Montvale, New Jersey), 1973, AFIPS Conference Proceedings, (LC 55-55701), p. 717-722, 5 refs.

This paper deals with possibilities which could occur in future society, suggesting the use of computers in the 21st century. Its main emphasis is on information exchange between computers and man, from a unified data base. Presented within are two scenarios dealing with possible future societies, one an open society with free choice still intact, and the other scenario is a model of a closed society, close to a computer-dictated society. Technological forecasts contained herein are vague because this paper is not a forecasting paper as such, but simply an opening for a session of forecasting.

Keywords: Communications/ Forecasting/

DAN:SSA:8/23/73

Vogel, Peter H., "A Basis for Technological Forecasting," Technological Forecasting, Volume I, 1970, p. 313-323, 17 refs.

This is a general article discussing certain assumptions and basic processes that are the basis for technological forecasting. Items of discussion include probabilistic assessments exploratory technological forecasting, normative technological forecasting, technology transfer and technology transfer space (four dimensions). The four dimensions of technology transfer space are as follows, synthesis-analysis dimension, collection-diffusion dimension, "use" dimension and time. Each are explained and illustrated by examples. This article does give some of the theoretical features of technological forecasting but would only be of interest in a discussion on forecasting for the sake of forecasting and not for developing forecasts.

Keywords: Technology transfer space/ Technology transfer/ Processes of technological forecasting/

MMG:NBS:12/12/73

Ware, Willis H., "The Computer in Your Future," in Arthur B. Bronwell, Science and Technology in the World of the Future, (Wiley-Interscience, New York), 1970, p. 303-327, 14 refs.

After a general discussion of the information needs of man and society the author develops a definition for computer power that includes not just number manipulation but also symbol manipulation and therefore information manipulation. This hints, in a very general manner, at some of the application areas of computers for handling our information needs. The author then discusses some hardware projections using data curves from 1955 to 1975. These curves include central processing unit/storage size, cost and speed and computing power (millions of additions/second). Based on the projections of the above hardware characteristics, the future for the following areas is discussed generally, on-line systems, interactive graphics, terminals, interfaces and applications for education, public services, networks and social implications.

The keyword for this paper is general. There are no new projections included nor even suggested. It is not a bad general discussion but should simply be considered as background information for the layman.

Keywords: Hardware capabilities/ General discussion/ Application areas/

MMG:NBS:1/21/74

Ware, W. H., "Future Computer Technology and Its Impact," the Rand Corporation, Santa Monica, California, P-3279, March 1966, 29 p.

After reviewing some of the principals of computers as reviewed in 1966, the author summarizes the progress of computer hardware, based on graph extrapolation, from 1955 to 1975. He then suggests things which in his opinion "computer technology can make possible." These predictions are for the time period of the mid-1980s and include areas of social impact, education and training, scientific discovery, weather control, engineering design, medicine and biology, data banks and the role of the Air Force.

Most of the predictions in the paper are very general and read a bit like science fiction but are nevertheless possible. The paper is not a primary reference but would make interesting reading for a newcomer to the field.

Keywords: Predictions/ Computer impact/

MMG:NBS:12/14/73

Weber, Ernest, Gordon K. Teal and A. George Schillinger (Eds.), "Technology Forecast for 1980," Van Nostrand Reinhold Company, New York, 1971, 242 p.

The Polytechnic Institute of Brooklyn is a technical university committed to keep in step with advances in science and engineering. As part of this commitment, it proposed a symposium for known scholars to explore future technology. The results of this symposium are presented in this book.

After an introduction on technological forecasting and a paper on the U.S. post-industrial society, the future technologies of the following areas are discussed, metals, ceramic materials, polymers, electronic materials, integrated electronics, superconductivity, lasers, holography, instrumentation, computer systems, computers in engineering, communications and automatic control. Probably the most interesting parts of this book are the discussion sections at the end of each paper. Some very excellent questions are posed and are answered directly and concisely. For example a few of the questions asked of the author on the computer systems section were, IBM's thoughts on minicomputers, the complexity of software, computer science curricula and computer aided instruction. These discussions often contain the most pertinent information on a subject area and are actually what make the book worth investigation.

Keywords: Technological forecasts/ Electronic materials/ Integrated electronics/ Superconductivity/ Laser technology/ Holography/ Computer systems/ Communications/

MMG:NBS:1/21/74

Wills, Gordon, David Ashton and Bernard Taylor, "Technological Forecasting and Corporate Strategy," American Elsevier Publishing Company, New York, 1969, 273 p.

Since the authors are concerned with the managerial aspects and implications of changing technology this book "attempts to answer the question of what changes in technology are likely to occur, and to solve the problem of how company planning and organization can effectively cope with them." The book is not designed to detail technological forecasting but is to study future technologies as they would impact on corporate strategy. The first part of the book is on 'Managing the Future' and includes articles on the management of forecasting, technological forecasting and corporate planning, long-range planning, industrial companies, marketing and national strategy. The second part examines forecasts of the future for polymers, metals, energy, transportation, communications, food, and computer systems. Some aspects of forecasting techniques in Britain are included. Each area examined includes a discussion of the methods used for forecasting and some predictions.

The section on computer systems includes the rate of innovation of new technologies, social impact of the computer, performance/price comparisons, cost per unit of computing power, areas of impact of computers and future computer system configurations.

Even though this book is a bit out of date now, it deserves consideration since it presents a very practical, managerial approach to technological forecasting and the future.

Keywords: Management/ Corporate planning/ Technological forecasts/ Materials/ Energy/ Transportation/ Communications/ Computer systems/

MMG:NBS:1/10/74

Withington, Frederic G., "Crystal Balling: Trends in EDP Management," Infosystems, 20:1 (January 1973), p. 20-21.

This article's title is misleading. The article's main theme is centralization/decentralization from the point of view of the large company. Four principles are presented as guides to determine a company's path; cost of duplicate system development, desirability of standard equipment, desire for uniform management reporting, and the economy of scale in computers. Arguments for centralization and decentralization for computer services (from physical equipment to systems design) are presented for the reader's absorption, and two applications, on opposite ends of the spectrum, are presented as evidence. Concise, convincing and interesting describe this informative article on computer facility centralization/decentralization.

Keywords: Centralization/ Decentralization/ Economies of scale/

DAN:SSA:11/1/73

Zellweger, Andres, "Five Year Computer Technology Forecast," Transportation Systems Center, Cambridge, Massachusetts, DOT-TSC-OST-72-23, December 1972, 98 p.

The report delineates the various computer system components and extrapolates past trends in light of industry goals and physical limitations to predict what individual components and entire systems will look like in the second half of this decade. The report will emphasize the nature of components (e.g. CPUs, primary memories, secondary memories, ultra large storage devices, etc.) and the system architectures that will be commercially available as 'off-the-shelf' items rather than one-of-a-kind systems that might exist in five years. (Author)

The methodology used in this report is a safe one and makes the predictions very sound. Unfortunately the predictions are for a very short time span and don't look very far into the future. It is nevertheless well worth studying.

Keywords: Computer storage devices/ Microprogramming/ Multiprocessing/ Networks/ Hardware/ Software/

MMG:NBS:12/17/73

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